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AIR&SPACE

Smithsonian

NOVEMBER 2003

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HOW'D THEY DO THAT?

TO SPIN OR NOT TO SPIN: THAT IS THE CONTROVERSY

(page 36)

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"The National Air and Space Museum has been a major part of our lives for almost 30 years – and today the new Steven F. Udvar-Hazy Center is, as well. Our contribution will help to ensure the success and growth of both."

— **DEPUTY DIRECTOR OF THE NATIONAL AIR AND SPACE MUSEUM LT. COLONEL DONALD S. LOPEZ, USAF (RET.), AND HIS WIFE GLINDEL.** They're standing in front of the North American P-51D Mustang now displayed in the World War II Aviation Gallery. It's one of the many aircraft Don Lopez piloted in his long and distinguished career.

He became a WWII fighter ace harassing Japanese forces in a shark-mouthed P-40 in China. He's been a test pilot, flown jets in the Korean War, taught at the U.S. Air Force Academy, worked on the Apollo-Saturn and Skylab programs, and written books on his experiences. He made aerospace history, and today he works to preserve it for the future. Don and Glyn Lopez care deeply for the National Air and Space Museum and its work to preserve the history of flight. They're honored to include the Museum in their will, and are proud members of the Smithsonian Legacy Society.

Find out how you can include the National Air and Space Museum in your estate plans. Fill out and return the reply form below, or call 202-633-2602. You may also e-mail gayle.union@nasm.si.edu. Help us preserve our legacy of flight!

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A&S 11-03

We found our best watch in a history book

In 1923 a small watchmaker in Europe built the first watch to display the day and date while using an automatic movement. Only 7 of these watches were ever made and we've only actually seen one of these masterpieces in a watch history book. Antique experts say these watches are so rare that they could fetch more than $500,000 at auction today.

As we researched early chronographs from Central Europe, we found that they were among the most complex and stylish works of art to be made during the Roaring 20's. And yet no one has attempted to replicate the vintage design and function of these early watches until now. The watch design that you see here has been painstakingly crafted with the inspiration of the earliest chronographs right down to the screw down crown. It is built with a classic 21 jewel automatic movement, the kind sought after by fine watch collectors.

From the sweeping second hand to the roman numerals on the unique ivory colored face, every detail has been carefully engineered to replicate the look and feel of the earliest chronographs. This six-hand movement includes two smaller dials that display the day and month. The third interior dial is a 24 hour military time clock in which the sun and the stars graphically depict AM and PM.

This watch's mechanical movement utilizes a self-winding mechanism inspired by John Harwood, who received the patent on the first automatic movement in 1923. Thus this watch never needs batteries and never needs to be manually wound. The watch comes in a beautiful case and interchangeable black and brown bands included.

This series of the 1923 S watch is a limited edition allowing you to wear a watch far more exclusive than most new high-end models.

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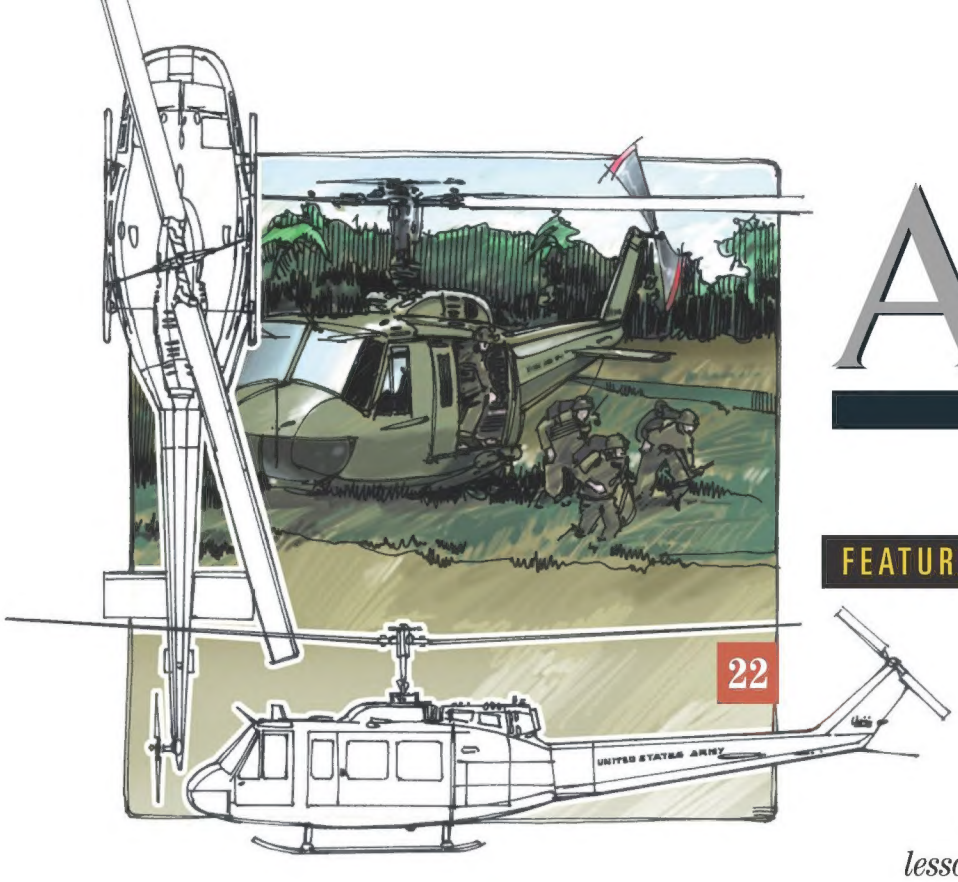

AIR&SPACE

Smithsonian

October/November 2003 ✳ Volume 18 • Number 4

FEATURES

Cover: *Photographer Mark Wagner took a shine to the Airbus A330-200 prototype as it gave the 1998 Farnborough airshow audience a preview of what to expect from a company taking off.*

DEPARTMENTS

THE CHRYSLER CROSSFIRE

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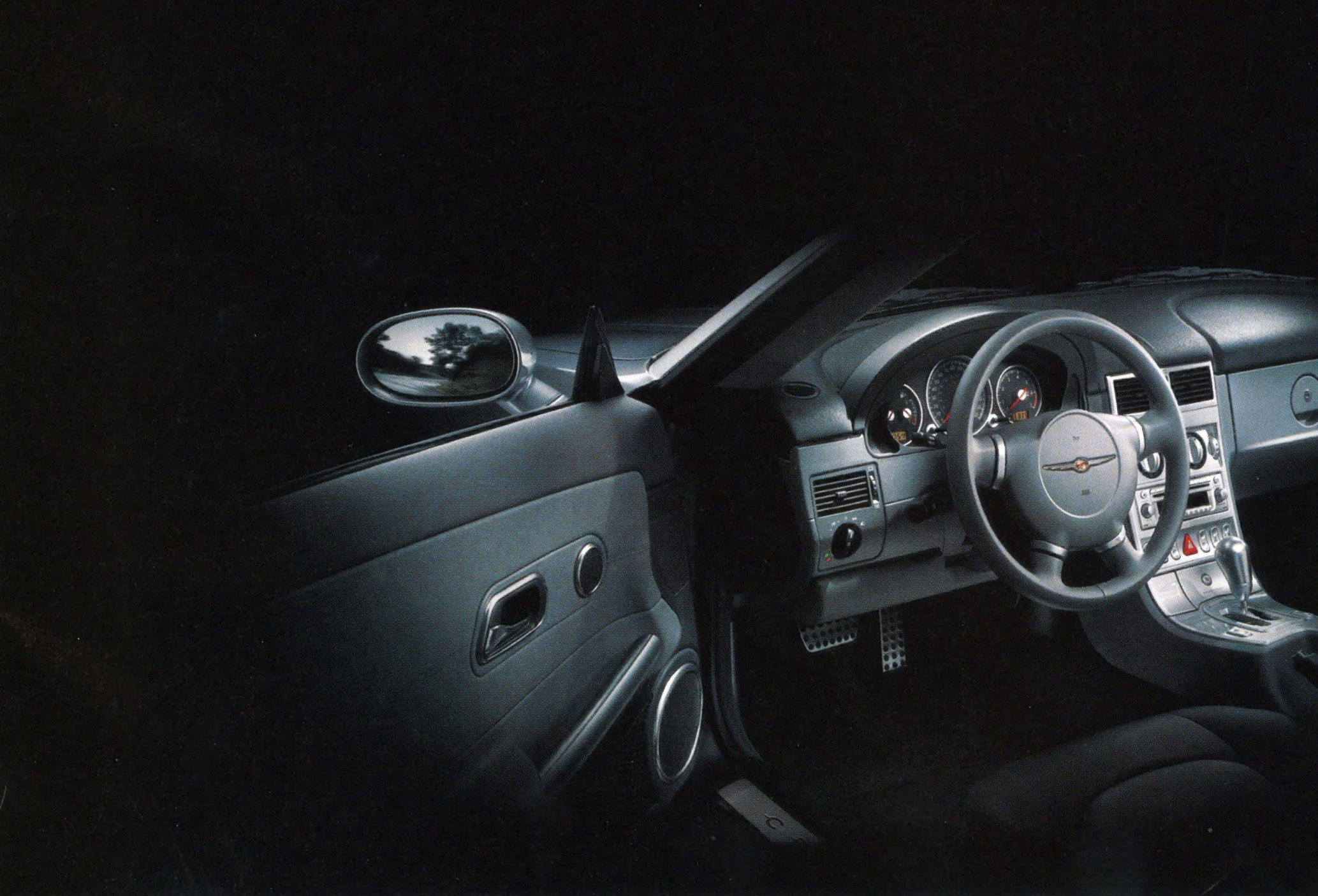

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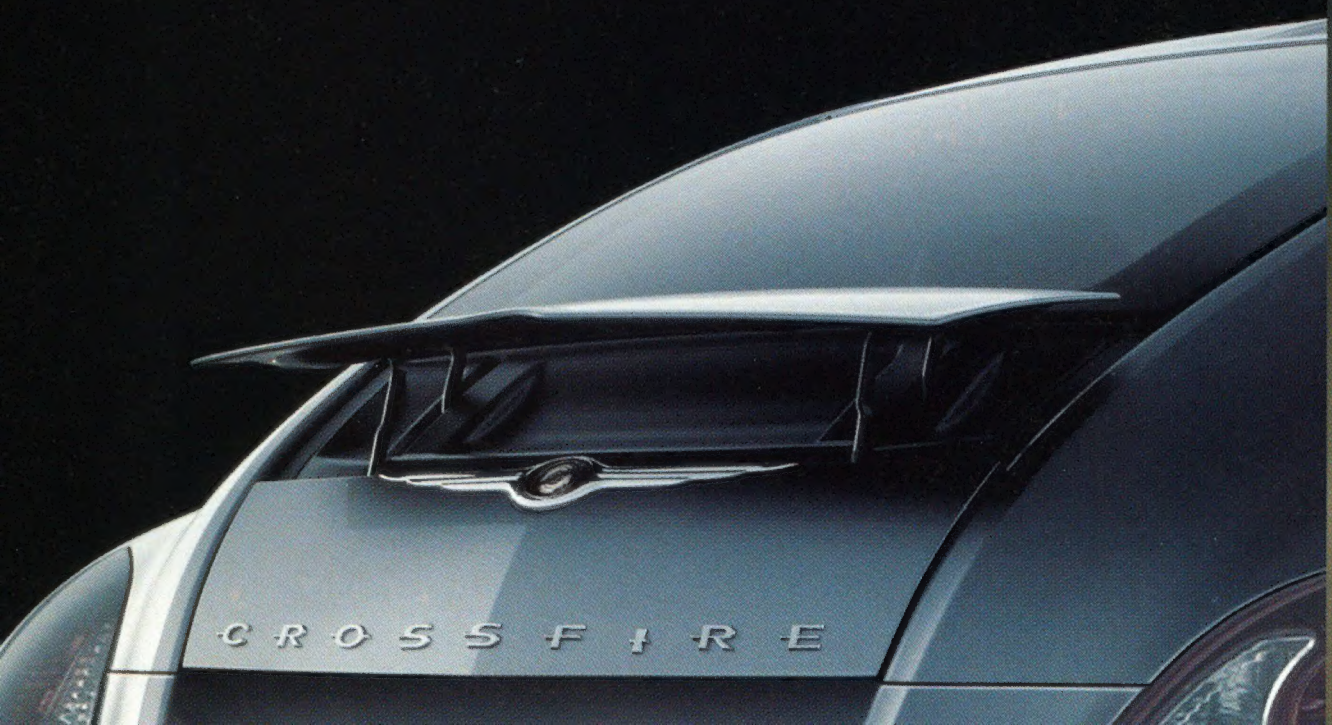

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Close-up Lens

When visitors enter the National Air and Space Museum this October, they may feel that something isn't quite right. Those who have been here before will be surprised to find that the 1903 Wright *Flyer*, which for more than a quarter-century has had a place of honor at the center of the Milestones of Flight gallery, is gone. Not to worry. The centerpiece of the world's most visited museum hasn't been the object of an elaborate heist. It has simply been moved into a special gallery that will allow unprecedented access to the world's ultimate aerospace milestone.

Millions of people have seen this amazing object, but in many ways this will be like seeing it for the first time. The Museum's exciting new exhibition, The Wright Brothers & the Invention of the Aerial Age, opens on October 11 (see "The Brothers of Invention," In the Museum, p. 16), and for the first time the *Flyer* is at floor level, where every part of this technical marvel can be seen up close. And it is an extraordinarily compelling artifact. You will not only see many of the fascinating details the Wrights designed and engineered, but you will experience feelings of awe and respect that are hard to put into words.

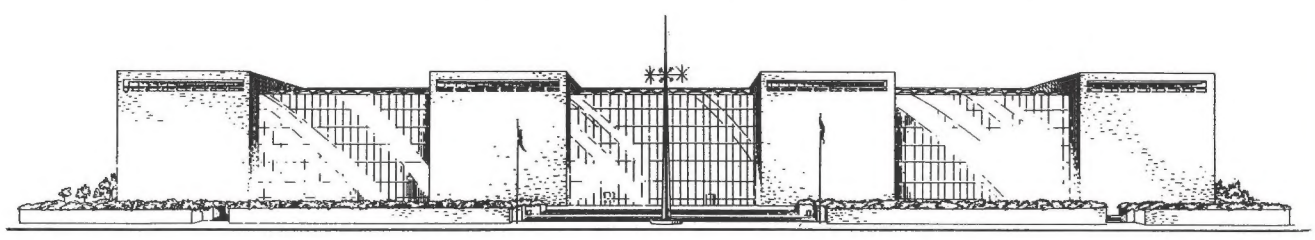
Visitors will be able to see the intricate stitching of the fabric covering, the Wrights' ingenious mechanical control system, details of the hand-built engine, the precision of the chain-and-sprocket transmission system, the flight data recording instruments, bracing wires, and fittings. A computer allows visitors to view photographs of the *Flyer*'s internal parts, taken when the airplane was disassembled in 1985.

But this exhibition offers a great deal more than just a view of the Wright *Flyer* in a new setting. An unprecedented array of material from the Museum's collection and on loan from museums and individuals from the United States and Europe is on display. With 170 artifacts, 260 photographs, a dozen mechanical and computer interactives, and a range of imaginative public programming, the gallery will be a centennial presentation without rival.

The exhibition explores who Wilbur and Orville Wright were, how they invented the airplane when so many others had failed, and how the world reacted to their revolutionary invention immediately after Kitty Hawk. You will see the original letter Wilbur wrote to the Smithsonian asking for information about flight, the actual wind tunnel instruments the brothers used to design their aircraft, a wingtip from their 1902 glider (the only surviving piece of any of the Wrights' gliders), the stopwatch the brothers used to time the flights, and the toolbox belonging to their mechanic and engine builder, Charlie Taylor.

Paired with this rich presentation of the Wrights' story is a colorful and entertaining portrayal of the world's responses to the birth of flight—artifacts representing everything from popular spectacle to the first commercial and military uses of the airplane to artworks inspired by aviation. Every visitor will find something of interest in The Wright Brothers & the Invention of the Aerial Age. No matter what aspect of this compelling story interests you, you simply must not miss it.

—J.R. Dailey is the director of the National Air and Space Museum.



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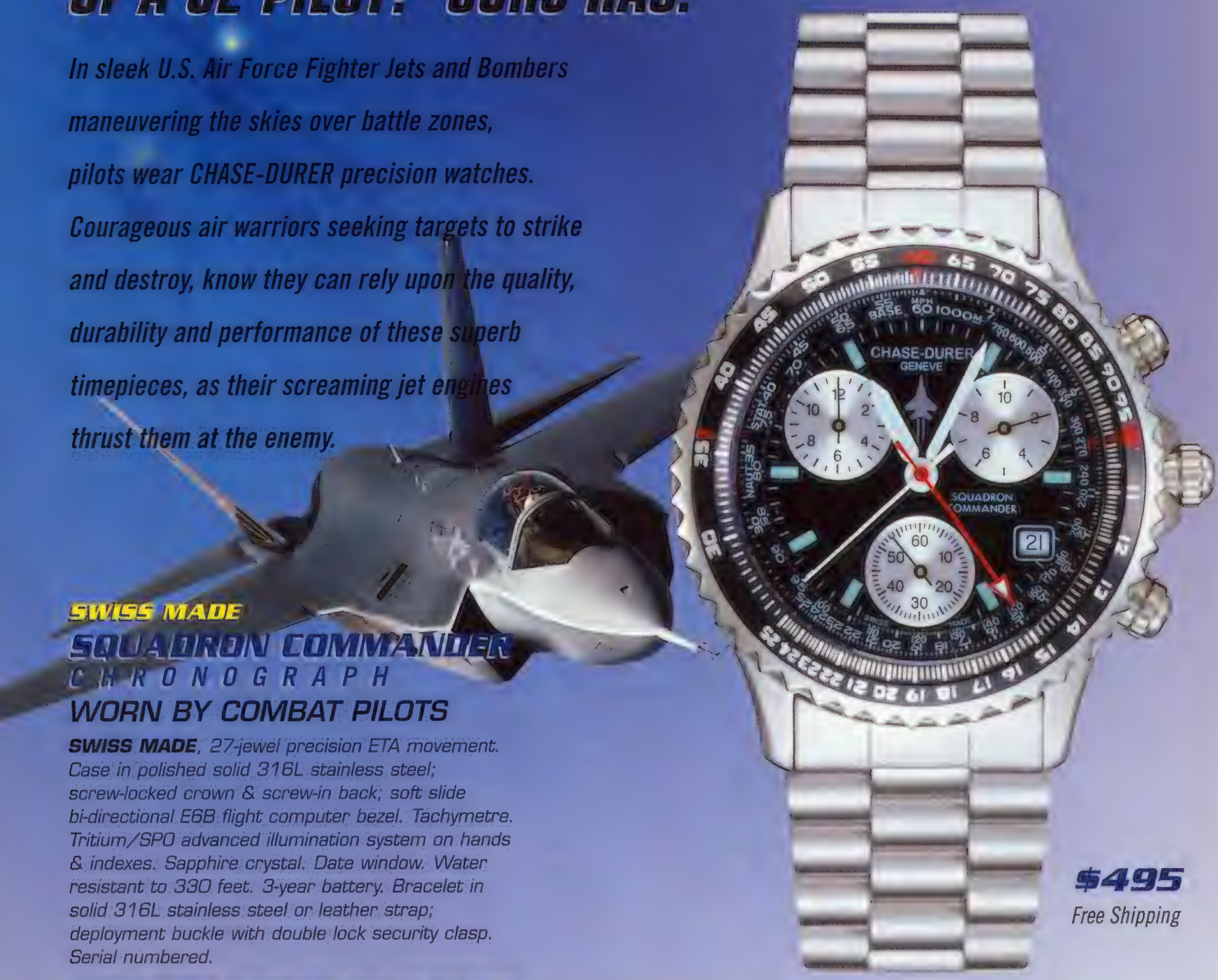

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LETTERS

The Dark Side of the DC-3 Story

I agree with your decision to put the DC-3 on the cover of your Centennial Edition (Feb./Mar. 2003); it was a revolutionary aircraft. However, I am shocked that you used an image of a United DC-3.

United operated the Boeing 247 and monopolized Boeing's production line, thus preventing TWA and other airlines from obtaining the 247. That is why Donald Douglas' company created the DC-3. Had it not been for United's greediness and the special situation it enjoyed with Boeing and Pratt & Whitney, there would not have been a need for a DC-3.

Brian Miller
Virginia Beach, Virginia

Who Said Anything About a Race?

I would like to clear up a few misconceptions created by Carl Hoffman's "Gambling on Las Vegas" (Soundings, June/July 2003).

Mr. Hoffman describes my demonstration as "one small part of the Aviation Nation airshow that Avery organized." Aviation Nation is the Nellis Air Force Base–Las Vegas Air Show, an official Air Force event organized by a duly appointed executive committee, not by me personally. World of Wings (WoW), a marketing and media property, is responsible for sponsorships, promotion, non-military media, VIP hospitality, and production of "Las Vegas Air Racing" for Aviation Nation. I do not produce any of these personally.

WoW has always promoted "Las Vegas Air Racing" as a demonstration. I have never claimed that I (or WoW) will, as Mr. Hoffman writes, "transform Unlimited air racing from a yearly cult event at Reno to a NASCAR-like Winston Cup series of big events…." WoW is developing a NASCAR-like model for sponsors and media to become involved with large airshows, but real air racing has never been part of the plan.

Mr. Hoffman was accurate when he quoted me saying, "The city of Las Vegas is sitting on the largest opportunity in the sport and aviation entertainment industry today." But, as I told him, real air racing will never occur at Nellis or any other military installation because at those places it is illegal.

Bob Avery
Founder and CEO
World of Wings, Inc.

Carl Hoffman responds: Bob Avery wants to have it both ways. He was careful to inform me, as I reported, that the air "racing" at the Nellis airshow would be a demonstration, but the press release distributed by his sponsor, Boyd Gaming, reads as follows (emphases mine): "Boyd Gaming Announces Continuing Sponsorship of Las Vegas Unlimited Air Races *in 2003" and goes on to quote Boyd's director of marketing: "We are extremely pleased to continue as title sponsor of this dramatic and exciting aerial* competition *that is one of the world's most spectacular events. Las Vegas is quickly becoming the home of the most visible air show in the world and its air* racing *component, now the largest outside of the national championships in Reno, are* [sic] *one of the weekend's show stoppers."*

As for his assertion that World of Wings, not he, is responsible for much of "Las Vegas Air Racing," throughout my interview with him, Avery used "I," "we," and "World of Wings" interchangeably to refer to what he and his company do.

NASA and Women: Not So Shocking

Nan Chase hit a clinker in her review of *The Mercury 13: The Untold Story of Thirteen American Women and the Dream of Space Flight* (Aug./Sept. 2003). She is entitled to her opinion of the book, but her reading of history includes the distressing expectation that people in the past should have thought and behaved according to the standards of the present. In the earliest days of spaceflight, the idea that capable women deserve the opportunity to go as far as their capabilities will take them, regardless of their gender, had yet to take hold at NASA. To deride those days as a "shocking period," as Chase does, is to impose on the past a standard for open-mindedness from the present day, and that is a practice that tends to muddle history.

Robert Ree
Riverside, California

The H-1 and I

"Silver Bullet" (Apr./May 2003) made me recall my experiences with the original H-1. In 1934, the Depression forced me to leave the University of Arizona before completing my senior year. I returned

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home to California. At the time, my father, William Seidel, was working at the Airplane Development Company as a pattern maker. The chief engineer at the plant was Dick Palmer, who had worked for Howard Hughes modifying a commercial version of a P-12 pursuit plane into a racer. Howard had flown that plane in the National Air Races at San Diego and was so impressed he asked Dick to design him a real racing plane. Dick agreed, and asked my father to join him. I told Dad I wanted to work on the project too. (I had worked in Dad's shop and had attended a technical high school where we had pattern making, machine shop, and foundry.) Beginning in March 1934, Dad and I worked in Al Gower's garage, helping to produce the H-1.

One of the most complicated pieces we had to make for the H-1 was the large fillet between the wing and the fuselage. The part had a small double curve at the leading edge, a large arc at the trailing edge, and a small curve to fit the surface of the wing. There were few pieces of equipment made for forming metal into complicated shapes like that, so all of the metal parts that couldn't be made in a conventional way were turned over to one of the metal workers. His name, I believe, was Karl, and he was a true metalsmith. We had a small trip hammer on which Karl was an artist. We made wood forms of the fillets; then Karl would take a sheet of aluminum alloy and get the sheet braking into general large curves. It was a good thing Karl had an unlimited supply of patience, because the work was hammer and fit, hammer and fit. I can't tell you how many hours he spent on those large fillets. The other part for which the trip hammer was used was the engine cowling. As for the cockpit, it was built to handle my six-foot-six frame, so we knew it would accommodate Howard, who was six-foot-two.

Gus A. Seidel
Aurora, Colorado

COURTESY GUS A. SEIDEL (2)

Reader Gus Seidel (above) had attended a technical high school that gave him the skills to work on Howard Hughes' magnificent H-1 racer (below).

Through my childhood and many decades beyond, I have had a love affair with the Hughes H-1. It was an unexpected delight that my first time at the Reno air races coincided with the H-1 replica's first time at Reno. I ran around the pit area taking pictures of Jim Wright's airplane.

On pages 48 and 49 of your article I paused to admire a photograph of the airplane. As I scrutinized the reflection on the vertical stabilizer, I was surprised to find a familiar image: It was me, admiring the airplane! With a light-colored cap and a blue shirt I can be seen transfixed.

Robert D. Waldo
Tacoma, Washington

Editors' note: We are sorry to report that on August 4, Jim Wright was killed in a crash of his H-1 replica (see p. 15).

What Was THAT?

I had a hard time believing the first sentence of Sam Goldberg's "Infrared Countermeasures" (How Things Work, June/July 2003): "... Israeli vacationers felt their chartered Arkia Airlines Boeing 757 shudder as it flew through the wakes

of two Soviet-designed SA-7 missiles...."

An Internet search showed that 757s have a maximum gross takeoff weight of 240,000 pounds or more. An SA-7 surface-to-air missile, depending on which Web site you believe, weighs about 22 pounds. So your article claims that two 22-pound missiles produced big enough wakes to cause a 757, which weighs 10,000 times more than one of the missiles, to "shudder." I don't buy that.

So what did the passengers feel? Perhaps the discharge of active countermeasures.

Stephanie M. Belser
Brewster, New York

Sam Goldberg replies: Shoulder-fired SAMs travel at between one and two times the speed of sound and thus produce shock waves, which could affect the attitude of even an airliner, especially if the missile and shock wave interrupted airflow over the aircraft's lift and control surfaces. It's possible that the discharge of countermeasures could have been felt or heard by passengers, but it's more likely that the shuddering was caused by a missile flyby.

One Helluva Loop

As a pilot in the 13th Bomb Squadron, Third Bomb Wing, I flew the B-57 Canberra in Japan and Korea and spent many hours practicing the Low Altitude Bombing System ("Exit Strategy," Apr./May 2003). I remember one flight very vividly. I was in the back seat of the dual-control C model being checked out on the LABS. We had already flown the "over the shoulder" release, and the instructor pilot said that there was another method that could be used. We roared along as low as possible at 450 knots and he pulled up as usual. However, when we reached the top inverted, he continued the loop with full power straight down, then pulled out. This was the only loop that I ever experienced in which the power was not reduced as we started down the backside. We got too close to the ground for my satisfaction.

The IP did explain to me that this was not the most desired method of bombing a target.

Major John Redrup
U.S. Air Force (ret.)
Franklin, North Carolina

Corrections

Aug./Sept. 2003 "The Comet Affair": The Ghost engine was made by de Havilland, not Rolls-Royce, and the United Kingdom's supply minister was Duncan Sandys, not Sandy.

June/July 2003 "Sticks for Hire": Due to an editing error, it was reported that John Mohr has a Federal Aviation Administration letter of authorization to fly all piston-engine aircraft. He does not.

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e-mail editors@airspacemag.si.edu. *You must include your full name, mailing address, and phone number.*

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Bird Banned for Bigness; Business Balks

CHAD SLATTERY

Santa Catalina Island, off the coast of California, is chronically cloudy, so the freight company Catalina Flying Boats moved up to Douglas C-47s like this one to transport more cargo in occasional windows of clear weather. And therein lies the rub.

Santa Catalina Island's governing body has been considering making a controversial addition to the list of local flora and fauna it has deemed endangered: the Gooney Bird.

The 76-square-mile island, located 22 miles off the Southern California coast, is primarily owned by the Santa Catalina Island Conservancy, a nonprofit organization with policies of strict environmentalism. Santa Catalina today reflects California in the 1920s, and the Conservancy is dedicated to keeping it that way.

Among the Conservancy's responsibilities is operating the island's 3,200-foot mountaintop airstrip. According to the group, the strip, built in 1939, "is approaching the end of its useful life," and there is no money to replace it. So the Conservancy decided to try extending its life by lowering the permissible weight of aircraft landing there. The only freight company that uses the strip, Catalina Flying Boats, flies a pair of 1945 Douglas C-47Ds—each too heavy to make the new weight limit, which was to go into effect last September 1.

CFB services the island from Long Beach, on the mainland. Its aircraft bring everything from fresh fish to pancake mix to newspapers—anything that will fit in the airplanes' cargo holds, each of which has a 7,500-pound, 1,000-cubic-foot capacity. CFB's 25 employees, two C-47s, and nine trucks will deliver the goods door to door for $15 per 50 pounds. Most of the cargo is bound for touristy Avalon, Santa Catalina's largest town, whose population swells from 3,500 to 10,000 on summer weekends. Each year CFB delivers five million pounds of just-in-time freight to the island's restaurants, hotels, and other small businesses—500,000 to 600,000 pounds per month in the summer. With the Conservancy owning 88 percent of the island's land, storage space is in short supply and restaurants in particular are not keen on relying on the island's barge service, which arrives from the mainland only three times a week. On any given day, CFB has some 20,000 pounds of perishables, mostly expensive cuts of fish and meat, on its loading dock awaiting delivery. Island businesses prefer CFB's door-to-door service; deliveries by water require recipients to come to the dock to claim the freight or to contract with a third-party delivery service.

CFB flies its C-47s to Santa Catalina three to five times per day. According to CFB owner Steve Franklin, the aircraft is uniquely suited to the mission: "The C-47's usefulness [in general] has been superseded by newer types of aircraft with better speed and higher altitude capabilities, but for our little niche, this is the perfect airplane." (And ironically, the island's strip itself was originally designed for DC-3s, the civilian version of the C-47.)

The C-47 was made for short-haul, short-field missions. Its relatively low acquisition cost ($150,000) more than makes up for the crankiness of its old piston engines and the expense of the avgas they burn. The only contemporary

aircraft that Franklin sees as a suitable replacement is the turbine-powered Cessna Caravan, but that aircraft has only 350 cubic feet of cargo space and cannot accept standard-size cargo pallets, as the C-47 can. The Caravan also has a price tag of more than $1 million, and its maintenance costs are greater than the C-47's. With the Caravan, Franklin would have to fly more and charge more.

But the real problem with flying freight to Santa Catalina isn't money, it's the weather. From May to August, a cold ocean current flowing south from Alaska is trapped along the Southern California coast beneath an inversion layer of warm air. The pesky "marine layer" of fog and low clouds sometimes leaves only a few hours of clear sky a day, severely limiting when CFB can fly. According to Franklin, operating smaller airplanes at greater frequencies raises the danger that his service would miss its weather "window," causing freight to back up (and perhaps rot) on the loading dock overnight, and also encourages pilots to push through iffy weather. It was this weather limitation that in 1992 persuaded Franklin to ditch the smaller Beech 18s he'd been using on the Santa Catalina run and buy C-47s.

For months, Franklin approached various government agencies for help with the impending weight restrictions. Finally, on August 18, with the restrictions just two weeks from taking effect, the Conservancy and Franklin reached an agreement to temporarily keep the C-47s flying. Asked what the agreement entailed, Conservancy president and CEO Ann Muscat said only that Franklin, who pays fees to land on the airstrip, "agreed to work with us" on getting the money needed for runway maintenance; she would give no further details. She added that the Conservancy hopes for a longer-term solution by partnering with the city of Avalon to apply for an FAA airport improvement grant.

For now, then, the Gooney Bird is safe.

—Mark Huber

UPDATE

Survivor

It's hard to say whether the launch of Gravity Probe-B is more impressive as a technical accomplishment or a political one. Begun 40 years ago, the project has been targeted for cancellation umpteen times, only to have Congressional champions restore funding ("The Methuselah Project," February/March 1987). GPB will use exquisitely tuned gyroscopes to try to detect a phenomenon called "frame-dragging," predicted by Albert Einstein, in which Earth warps the fabric of space-time as it rotates. Launch is planned, finally, for November.

KATHERINE STEPHENSON, STANFORD UNIVERSITY/LMMS

Ba-da-boom

On only five occasions in history has a propulsion system entirely new to aviation lifted an airplane off the ground. (If you are now ticking off these systems, you can check your answers at the end of this page.)* A team of engineers at the Air Force Research Laboratory at Wright-Patterson Air Force Base in Dayton, Ohio, hopes soon to claim another such first by flying an airplane with a pulse detonation engine, or PDE.

The test airplane, a Rutan Long-EZ homebuilt, made a first public (non-flying) appearance at the Oshkosh airshow in July. A Junkyard Wars creation of pulleys, belts, and blowers hung from the airplane's belly. Four organ-pipe tubes jutted from its tail. And what the heck was that in between? Auto parts?

At its simplest, a PDE is a tube, open at one end, that's filled with a fuel-air mixture through a valve at the closed end. The mixture is ignited and *crack!*—a shock wave propagates down the tube, compressing and detonating the fuel as it goes. The gas explodes out the end of the tube, producing thrust.

"It's an old idea," says Fred Schauer, a civilian leading the Air Force research effort. "Originally it was developed by the Germans in the late '20s. They were trying to make the original pulse jet from the V-1 buzz bombs into a pulse detonation engine." Schauer's team, supported by an engineering contractor, Innovative Scientific Solutions, Inc. (ISSI), has been running PDEs since 1998. The engine fitted to the Long-EZ, he stresses, is a test-bed device, not a finished powerplant. It has four tubes, each firing 20 times per second. A two-stroke engine spins a pair of truck superchargers to deliver fuel and air to the tubes, and a cylinder head from a General Motors Quad 4 automobile engine controls the flow. (Don't try to find a Quad 4 head in any Dayton-area junkyard, advises ISSI engineer Craig Neuroth. The Air Force bought them all.)

The detonation wave, which does the same job as the compressor and turbine of a jet—but without any moving parts—makes the PDE simpler than a turbojet, yet capable of supersonic thrust with greater efficiency than an afterburning jet engine. And unlike a ramjet, it can generate thrust at a standstill. PDEs could power airplanes or missiles to more than Mach 5 speeds—more than 3,200 mph. In a nod to that fact, the Air Force engineers have christened their airplane *Borealis*—a cryptic allusion to the Aurora, the mysterious (some say mythical) hypersonic craft that the Air Force supposedly hides at Area 51, its secret base in Nevada.

Borealis won't go quite that fast. The goal is to get off the ground sometime this fall, then reach a maximum of 200 mph and gain some experience with issues such as the impact of intense 80-Hertz vibration from the engine on the airplane and the pilot. Burt Rutan's Scaled Composites company is supporting the flight-test program from its headquarters in Mojave, California.

Some engineers think that PDEs have enormous potential. In 2001, Pratt & Whitney quietly acquired the PDE division of Adroit Systems, a pioneer in the new technology. Rolls-Royce has outlined a supersonic transport engine that is a hybrid of a PDE and a jet. One GE Web site says of the PDE: "The jump in technology from the propeller to the jet engine was big. The next step will be even bigger."

BILL SWEETMAN

Not a top-fuel dragster but potentially much faster: A pulse detonation engine could hit Mach 5 someday.

*in chronological order: internal combustion engine (Wright), rocket (Opel), turbojet (Heinkel), human (MacCready) , and solar-electric (ditto).

—Bill Sweetman

Down in the WIMP Mines

Planets, stars, and gas clouds—the stuff we can see—account for only 10 percent of the universe's mass, and physicists think the remainder, called dark matter, is made up of "weakly interacting massive particles" (WIMPs). Now a new $4.8 million research laboratory dedicated to dark matter research has opened 3,300 feet below the North Yorkshire moors of England, in the Boulby Potash Mine, one of the deepest in the nation. The Anglo-U.S. team working down in its miles of passages hopes to be the first to detect WIMPs and thereby prove their existence. If successful, the discovery will rank as one of the great scientific advancements of our time. It would be "akin to learning that the Earth was not the center of the universe in the 16th century," says David Cline of the University of California at Los Angeles and one of the U.S. contingent of dark matter researchers.

Scientists proposed the existence of dark matter as early as the 1930s by studying the movements of stars within galaxies. They could deduce the mass of a galaxy by calculating the velocity at which the stars within it rotate. By studying how stars move in relation to each other, physicists realized that although the stars should be flying apart, something was holding them together, providing evidence that the mass of a galaxy is greater than the sum of all its visible components. Proving what that dark matter is made of is the challenge now facing the Boulby research team, a group from 10 universities working together as The Boulby Dark Matter Collaboration.

"Computer simulations of the Big Bang and generation of cosmic structures strongly support the idea of dark matter being some sort of particle," says Sean Paling, part of the U.K. dark matter team based at Sheffield University. "And the evidence points toward a slow moving, heavy particle."

Although billions of such particles pass through us every second, they can be detected only if they collide with atom nuclei—and such collisions are rare. The Boulby scientists are using three types of sensor—solid, liquid, and gas—to try to detect collisions. The idea is that colliding WIMPs will interact with the material inside the sensor and, depending on what that material is, give off energy in the form of light, heat, or an electrical charge. "Imagine the WIMP as an invisible cue ball in a game of snooker, but the object balls can be seen," explains Jeff Martoff, a professor of physics at Temple University in Philadelphia. "By watching the object balls recoil, we can infer the direction from which the cue ball came, and some information about how hard it was hit."

The target within the NaIAD sensor is made of solid sodium iodide crystals, the ZEPLIN sensor uses liquid xenon, and the DRIFT experiment uses carbon disulfide gas. The compact-car-size devices are located deep beneath the ground to prevent particles other than WIMPs from reaching the target material. Even in their subterranean environment, the sensors have to be protected by outer coatings of lead and copper. Without this protection, even the minute residual background radiation underground would swamp the very rare signal from WIMPs.

Inside the brightly painted clean room in a new 250-foot-long laboratory, Paling

COURTESY PPARC

Researchers looking for rare WIMPs place their detectors deep down where surface background radiation can't penetrate to obscure the WIMPs' effects. The Boulby mine in England also has exceptionally low radiation from minerals below ground.

HEADS UP

The Columbia Investigation

The Columbia Accident Investigation Board's 248-page report, released on August 26, makes 15 recommendations that it believes NASA should comply with before resuming shuttle launches. The report also notes that the agency's culture needs a complete overhaul if the space shuttle is to fly successfully in the long term, and suggests that the White House, Congress, and the general public must decide if they are financially committed to supporting the manned exploration of space. Volume One of the report can be viewed or downloaded from the Web sites of the CAIB (*www.caib.us*) and NASA (*www.nasa.gov/columbia*). Bound copies are expected to be available for purchase from the Government Printing Office in November.

says that the team is coming close to identifying WIMPs. It is able to recognize them by knowing the range of WIMP characteristics, including the likely mass of the "cue ball" and the seasonal variation in collision velocities as the Earth orbits the sun and passes through the headwind of WIMPs produced by the solar system's passage through space.

Researchers say that now it's only a matter of time before WIMPs emerge from the darkness.

—Carolyn Fry

The One-Pound Rescue Box

Beep, beep… "Please come to my rescue," say PLBs like this one.

ACR ELECTRONICS, INC.

The morning of July 1 was bright and clear near Waterbury, Vermont—beautiful weather for a hike. But the eight Boy Scouts who gathered in a clearing near the edge of the Vermont State Forest that morning were not out to enjoy nature. With everyone from their parents to Vermont Governor Jim Douglas and the media watching, the scouts flipped a switch on a small, one-pound device that was packed with electronics.

Within 10 minutes, the Vermont Civil Air Patrol, with assistance from the State Police, had homed in on a signal emanating from the device and "rescued" the scouts. On the day the devices were first made available for public use, the rescuers became the first persons to test a new device, called a personal locator beacon (PLB).

A scaled-down version of the Emergency Locator Transmitter (ELT) found in airplanes, PLBs cost about $500. Like ELTs, the beacons transmit a digital signal on a frequency of 406 MHz that is picked up by the COSPAS-SARSAT satellite system used to locate aircraft and ships in distress. The signal is relayed to a nationwide monitoring system supervised by the U.S. Air Force Rescue Coordination Center and the National Oceanic and Atmospheric Administration. The system can locate a beacon to within three miles. A code embedded in the signal allows rescuers to identify the device's registered owner.

The exercise, which was organized by the CAP along with the Vermont State Police and the Air Force Rescue Coordination Center, involved local scouts from troop 79 in Northfield and troop 42 in the town of Georgia. "It was supposed to be a simulated broken leg because Boy Scouts aren't supposed to get lost. That couldn't be used as an excuse [to call for a rescue]," said 14-year-old Mathew Edson of Troop 42, one of the scouts who were helping the "victim."

Colonel James Rowell, commander of the CAP's Vermont Wing, said PLBs have the potential to save numerous lives, as well as making search and rescue missions more effective and timely. "Many search and rescue missions are time consuming," Rowell said. "But with the PLB…the Air Force Rescue Coordination Center can pick that signal up almost within an instant if the satellite is positioned correctly."

Rowell reported that a Cessna 210 that serves as the organization's search aircraft was able to pick up the relayed PLB signal on its first attempt, using direction-finding equipment. "This proved to be very accurate…and very suitable for Vermont mountains," he said.

—Kelli B. Grant

WINNING WAYS

CAROLINE SHEEN

J. Roy Shoffner (seated) greets fans of Glacier Girl, *winner of the Rolls-Royce Aviation Heritage Trophy.*

Ice Queen

It was no surprise to the tens of thousands who attended the 2003 Vectren Dayton Air Show in Ohio last July: The judges and the audience both picked the Lockheed P-38F *Glacier Girl* as the grand champion. A panel of judges awarded the Rolls-Royce Aviation Heritage Trophy to P-38 owner J. Roy Shoffner of Middlesboro, Kentucky, for the show's most authentic aircraft and historically accurate restoration. Airshow attendees voted *Glacier Girl* the winner of the National Aviation Hall of Fame People's Choice Award, no doubt in part because the aircraft braved 50 years on and beneath the Greenland glacier and was excavated in 1992 from 268 feet of ice. After a 14-week mission to recover the aircraft, Shoffner's team took more than 10 years to restore it to flying condition. Almost 80 percent of the parts in the original aircraft were used in the restoration.

For more about the restoration and other P-38s still flying, watch for our Feb./Mar. 2004 issue.

LOSSES

Tom "Sharkbait" Delashaw, an F-104 pilot who toured with the airshow demonstration duo Starfighters ("The Fastest Show on Earth," Apr./May 2001), died in the crash of a Hawker Hunter jet fighter on July 22. He was 67.

A graduate of the U.S. Air Force Fighter Weapons School, Delashaw set his unit's speed record of 1,600 mph and the altitude record of 92,000 feet in the F-104 and was awarded the Distinguished Flying Cross for F-4 Phantom combat missions in Vietnam. He was ferrying the Hunter, a 1957 British jet, to its owner in Canada and had just taken off from the Wilkes-Barre/Scranton International Airport in Pennsylvania.

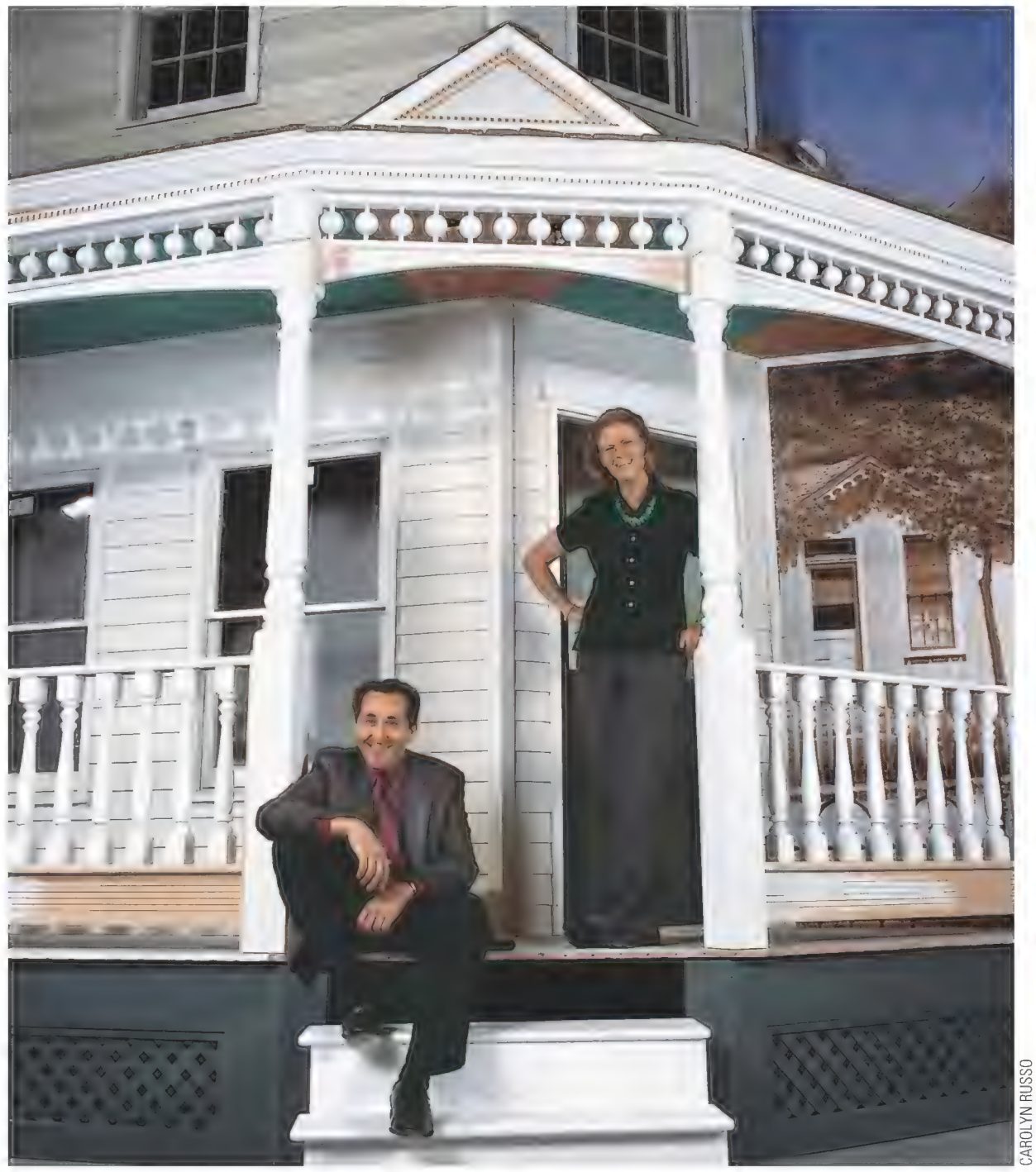
Najeeb Halaby, former head of the Federal Aviation Administration and Pan American World Airways, died of congestive heart failure on July 2 at his home in McLean, Virginia. He was 87.

Halaby was also a Navy test pilot and 1995 recipient of the National Air and Space Museum Trophy, awarded for lifetime achievement.

James Wright, whose much-admired replica of the Hughes H-1 racer was featured in "Silver Bullet" (Apr./May 2003), died in a crash of that airplane on August 4 in Yellowstone National Park, Wyoming. He was 53.

Wright, the owner of an industrial tool-making business, led a team of craftmen in the three-year project to build the replica. He set a world speed record in it at the National Championship Air Races in Reno, Nevada last year.

The Brothers of Invention



CAROLYN RUSSO

Curator Peter Jakab and designer Barbara Brennan replicated the facade of the Wright homestead to use as a stage for theatrical programs.

The National Air and Space Museum's latest exhibition, "The Wright Brothers and the Invention of the Aerial Age," which opens October 11, has a leg up on all other commemorations of this year's centennial of flight: It boasts the ultimate artifact, the original 1903 Wright *Flyer*. The world's first airplane usually hangs from the ceiling in the Museum's center hall, but exhibition curator Peter Jakab decided to lower it to eye level so visitors can see the Wright brothers' elegant engineering up close.

Karl Heinzel, assistant shop foreman at the Museum's restoration facility, will take the *Flyer* apart to ease its move into a 5,400-square-foot exhibit area, which will also display representations of one of the Wrights' bicycle shops and the front porch of their house on Hawthorn Street in Dayton, Ohio. Heinzel first became familiar with the airplane in 1984, when it was taken down for some preservation work. "The whole thing is put together with wood screws, so it's not difficult [to disassemble]," he says. "But we use the classic white gloves on this one," usually reserved for fragile artifacts, like aging documents.

While the logistics of moving the *Flyer* makes for high drama, some of the most riveting objects in the exhibition are also the most commonplace. What better way to get beyond the image of Wilbur and Orville Wright as icons than to see Orville's report card from his junior year in high school? The man who helped master the air received an 80 in geometry (he could be a restless student). That same year, his older brother Wilbur was cloistered at home, recovering from a sporting accident and a subsequent depression that his family feared he might never break out of. "Wilbur was teetering on the brink of becoming that stock character of Victorian family life—the perpetual invalid," write Jakab and fellow Museum curator Tom Crouch in *The Wright Brothers and the Invention of the Aerial Age*, a 240-page coffee-table book that accompanies the exhibition (read an excerpt on p. 75).

The fact that the brothers started with no aeronautical experience and produced the world's first workable airplane in just six years is nothing short of astounding. One of the difficulties they had to deal with was the cold, windy weather on the dunes of Kitty Hawk, North Carolina. On December 17, 1903, they made the world's first flights in a powered, heavier-than-air machine, but they had to call it quits after a gust of wind tossed the *Flyer* end over end. Severely damaged, it never flew again. In preparation for its display at the Massachusetts Institute of Technology, the *Flyer* was restored in 1916, and Orville restored it again in 1926 and '27 before it was loaned to the Science Museum in London. Still, much of what remains flew at Kitty Hawk in 1903.

Wilbur and Orville spent months testing different propeller shapes. The one they eventually used on the *Flyer*, painted grey and splintered at both ends as a result of the mishap in 1903, sits on a table in the back of the exhibit. Though it looks primitive, it actually represents one of the Wrights' most creative breakthroughs. Jakab and Crouch explain in their book that the brothers were the first to understand that the propeller works as a rotary wing.

Other small objects with big stories include the Cayley silver medal, which English aeronautical pioneer Sir George Cayley made in 1799 to commemorate his work in aeronautics. He conceptualized the basic configuration of the modern airplane—separate wings, controls, and propulsion system—and flew the first successful small-scale gliders. The medal has never left Britain, but in honor of the Museum's exhibit, the Science Museum in London agreed to let

it go to the United States. Jakab accompanied the one-of-a-kind artifact, which had its own airplane seat, on its journey across the Atlantic.

Visitors can also see the stopwatch the Wrights used to time their first flights and the flight record for May 25, 1910, the only day the brothers flew together and the only time they took their father up (with Orville as pilot).

In the end, though, what packs the biggest punch in the exhibition are the things that help distinguish the brothers as separate personalities and underscore their family's role in their success. Jakab plans to have an actress play the brothers' sister, Katharine, who was just 15 when their mother died, and, as the sole daughter, became the female head of the household. Neither Wilbur nor Orville ever married, and Katharine herself waited until she was 52. Jakab and Crouch point out in their book that the men enjoyed "the benefits of life in a warm and stable family, while escaping the responsibilities that consumed the time and energy of married men.... [C]onfident in the love, support and unquestioning loyalty of their sister, they could focus their energies on their experiments. Without those advantages, it is by no means probable that they could have succeeded."

Katharine did grumble occasionally, at least once about Orville's mandolin, which is also part of the exhibition. "Orv has begun lessons on his mandolin and we are getting even with the neighborhood for the noise they have made on pianos," she wrote her father in 1900. "He sits around and picks that thing until I can hardly stay in the house."

Showing these objects of ordinary life—the report card, the stopwatch, the mandolin—helps correct the overblown image of the brothers as geniuses operating far outside the sphere of the average American.

Wilbur wasn't much better on the harmonica.

—Mary Collins

The Countdown Continues

The National Air and Space Museum's Steven F. Udvar-Hazy Center in northern Virginia will open in two months, on December 15, giving visitors the opportunity to see such artifacts as a Grumman F9F-6 Cougar prototype, which made its first flight on September 20, 1951. The F9F-6 was the U.S. Navy's first swept-wing, carrier-based jet fighter. Armed with four 20-mm cannon, the Cougar was fitted with two wing racks, which could carry up to 3,000 pounds of bombs or 150-gallon fuel tanks. Grumman also manufactured an unarmed reconnaissance version of the F9F-6. From 1955 to 1957, Cougars were flown by the Navy's flight demonstration team, the Blue Angels.

NASM (SI NEG. #97-16203)

ERIC LONG

The Steven F. Udvar-Hazy Center has a glass-walled observation deck, from which visitors can observe nearby air traffic.

MUSEUM CALENDAR

October 15 General Electric Aviation Lecture Series: "An Evening With Chuck Yeager." Brigadier General Charles E. "Chuck" Yeager pushed the limits of flight in 1947 to become the first pilot to break the sound barrier. In his annual lecture, Yeager will share memories of his climb from enlisted man in the U.S. Army Air Corps to Bell X-1 test pilot. Free tickets may be obtained at the Museum's theater box office, through *www.tickets.com*, or by calling (800) 529-2440. Lockheed Martin IMAX Theater, 7:30 p.m.

Hours The National Air and Space Museum is open 10 a.m. to 5:30 p.m. seven days a week. General admission is free.

Location The Museum is located on the National Mall at 7th Street and Independence Avenue SW, Washington, D.C., west of the U.S. Capitol. The closest Metro station is L'Enfant Plaza.

Lockheed Martin IMAX Theater Experience the thrill of films produced in IMAX and projected onto a screen seven stories wide and five stories high. Feature films include *To Fly!* and *Space Station 3D*, which documents life and work aboard the International Space Station. For more information, call (202) 357-1886 or (202) 357-2700.

Albert Einstein Planetarium Realistic astronomical experiences are reproduced under the planetarium's 70-foot-high dome. For information about show schedules, call (202) 357-1686.

Events The Museum offers the public a variety of programs, including lectures, concerts, and educational workshops. To receive the latest calendar of events by mail, write to: CALENDAR, National Air and Space Museum, Room 3733, Smithsonian Institution, Washington, DC 20560-0321; an online list of events is available at *www.nasm.si.edu*.

Except where noted, no tickets or reservations are required. To find out more, visit www.nasm.edu *or call the Smithsonian Information line at (202) 357-2700; TTY (202) 357-1729.*

Memoirs of a Pan Am Brat

Recently I paid $202.50 for seven cocktail glasses auctioned on eBay. I know, that works out to $29 each. But these are Pan American World Airways glasses, from a flying era that's just a fabled memory now, so humor me. I'm a Pan Am brat, and with all the miles I logged on the system's routes in the 1940s and '50s, I probably sipped an underage gin and tonic in one of them.

I made my first flight alone at the grown-up age of 12. The son of a company employee, I rode SUBLO, or "subject to load"—I got some no-show's seat. I remember the flight vividly. I boarded a double-deck Boeing 377 Stratocruiser (Pan Am called them Stratoclippers) in Los Angeles, and took a seat just forward of the lounge stairwell. As the ground crew pulled the boarding stairs away and the purser secured the door, every eye was locked on the stewardess in the trim blue uniform at the head of the cabin while she showed us how the yellow life vest worked. No one talked, no one read, no one fumbled through a briefcase. This was important stuff. In the early 1950s, the Territory of Hawaii was nine, maybe 10 hours away, depending on the winds, and the flight was all over open water—true point-of-no-return flying.

The lady next to me followed along on my safety card. "It'll be okay," I told her. "We'll be fine." At 12, I could pull off a seasoned traveler's nonchalance—I had already retired two passports before I was old enough to get a driver's license.

"Sshhh!" she hissed. "I'm trying to hear."

The stewardess' voice carried over the sharp, arrhythmic coughs of the idling engines. "No pens or pencils. No pointed objects. Ladies, take off your high heels."

A second stewardess handed out

ERIC LONG

Mementos like these, from the early years of Pan American World Airlines, remind self-described Pan Am brat Doug Wilburn of his years traveling back and forth across the Pacific as a "subject to load" passenger.

Chiclets and gave each seatbelt a tightening tug. The pilot ran the four engines up to full power, the yellow tips of the four-blade propellers blurring into circles. The 14,000-horsepower rumble became a towering roar. Everything and everyone vibrated, and the airframe creaked and quivered. My seatmate gripped her armrest. I gazed out over the wing and thought about dinner. The pilot released the brake and the airplane rumbled past a couple of parked Western DC-3s and smoothly took to the air. He banked the airplane and began a climbing turn, heading toward the setting sun.

My father had joined the sales department of Pan American World Airways just after World War II, when air travel was far from commonplace. Back then, people thought getting on an airplane was a bit dicey. If you really wanted to go somewhere, you took the train. My grandmother often told my mother she wished my father would forget this airline nonsense as everyone knew the airplane wasn't here to stay. But it stayed and we stayed.

I remember motoring along the marshes of south San Francisco Bay in 1946, my father pointing out the seaplane ramps and the Pan Am Clippers pushing through the water to their moorings. The great Boeing 314 flying boats still symbolized the romance of overwater odysseys to strange lands, but their age passed with World War II, and the post-war period brought new aircraft. The transportation business had entire infestations of bugs to work out—departures, for instance.

In the mid-1940s, when a flight was scheduled to depart, a whole group of airline employees would be at the gate, including the guy who sold the tickets. Standard procedure was to wait at the terminal for at least half an hour after takeoff in case the airplane developed some glitch and had to turn back. When this happened, the staff would gather up the passengers and find them rooms. Airport hotels and ground transportation were still a way off. I spent more than a few late nights in our 1945 Pontiac shuttling strangers to hotels.

We'd been with Pan American less than a year when my father said there was a good chance of a transfer to Australia. Well, we didn't get Australia, but in Pan Am's old Pacific-Alaska Division, we got everything else. By the time I was 11, I had flown every route in the Far East, helped along by company families stationed on Wake, Guam, Canton Island, Fiji, Tokyo, Hong Kong, Manila, Saigon, and Rangoon.

After three years in Honolulu, my father came home one afternoon and announced we were being transferred to Bangkok. "They used to call it 'Siam,' " he said, showing us pictures. I saw glittering golden temples and marvelous horned animals standing belly-deep in bright green fields.

"I leave the day after tomorrow. Sell the car, pack up the house."

The years in Bangkok were, to be charitable, interesting. "Exotic" quickly gave way to the realities of heat, dirt, reptiles, and the improvisations of daily life. Every so often, when my mother reached the end of her rope, we would hop on an airplane and fly to another station for a few days, always SUBLO. On one flight back from Hong Kong, there were two seats for three of us. During that always-scary takeoff from Kai Tak in Hong Kong, I stayed in the restroom.

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In 1956, Pan Am transferred my father to Singapore. Because the American School at the new station only went up through a very sketchy ninth grade, I ran out of school. So back I went to Punahou in Honolulu and eventually San Diego, becoming a commuter on a grand scale. At Christmas, Easter, and in the summers, other kids would get in cars and go home. I'd fly 2,500 miles to Honolulu or 14,000 miles to the Far East.

The trans-Pacific haul was a long one, but every takeoff promised adventure. Nine-plus hours to Honolulu, then a change of airplanes and a night takeoff for the 12 hours to Wake Island. Since we gained time flying west, we'd always land close to two in the morning and stumble out half asleep while the aircraft was refueled. Then six more hours to Guam, arriving around six in the morning to be greeted in the transit lounge by some guy with a microphone who did a morning radio show called "Meet the Clipper."

After two hours, back up we went, bound for Manila six and a half hours away. Once we blew a tire on landing, which gave us something to talk about during the interminable layover. Manila was a bear—a marginal terminal and grim transit facilities in a sort of open building (no screens) barely lit by whatever power source happened to be working. We would invariably get in well before dawn, just as the mosquito population roused itself for breakfast, and we'd be interned in the almost-barren transit lounge until the afternoon flight out. Then we were off to Saigon, about a four-hour flight. We spent an hour on the ground at Tan Son Nhut sipping some kind of warm orange drink, then made a two-hour dash down the dark green jungles of the Malay Peninsula, arriving at last at Paya Lebar in Singapore, some 40-odd sweaty, shower-free hours after leaving Los Angeles.

But time passed surprisingly quickly on the Stratoclipper. It was the last aircraft that made flying a luxurious voyage rather than the cattle car drudgery the 707s ushered in. We dozed, read, and visited the crew on the flight deck. Once, on the Saigon-Manila leg, the captain let me sit in the left seat and take the controls. And we ate. My God, how we ate. Wake-up snack, breakfast, lunch, afternoon hors d'oeuvres, and a multi-course dinner—a choice of prime rib, calf's sweetbread in Madeira sauce, lobster thermidor, or Long Island duckling with peaches, followed by chocolate and coffee eclairs. I'm not kidding. I've got the menu.

Passengers also talked with each other, wandering up and down the aisle or gathering in the lower lounge to watch a Pacific sunset out the portholes. Some passengers did more than talk. On a flight from Tokyo to Honolulu, one enterprising lady set up shop in the lounge after lights out. I had a seat nearby and wondered why one guy after another kept walking back for a nightcap. Eventually, the navigator and engineer evicted her and roped the lounge off.

The laps of that luxury were the overhead pull-down berths. On rare occasions, one would go unreserved and a stewardess would ask, "Do you want it?" I would be in it like a shot, stretched between fresh, white sheets, trying desperately to stay awake long enough to enjoy the sensation while the drone of the engines a few yards away sang me to sleep. In the morning, as a high-altitude dawn lit the cabin, a hand offering a glass of juice would come through the curtains. "Breakfast in 15 minutes," the stewardess would say. "We're two hours out of Honolulu."

I've heard that the old Repulse Bay Hotel in Hong Kong has been torn down to make room for a new something or other. I understand: It's business. But I remember affectionately having afternoon tea there. Like the old hotel, the planes and their era are all gone now. That's why I spent $202.50 for seven glasses.

—Doug Wilburn

Dude, Where's My Airplane?

As darkness fell on December 26, 2001, a 1946 Aeronca Champion took off from a small airstrip near Petaluma, California. The tandem two-seater rose above the green hills of the Coast Ranges and spent more than an hour circling over vineyards, cattle ranches, and Christmas-lit towns. It was a pleasant spree, with only one discordant note: The airplane had no pilot.

Paul Clary III had started the Champion around 4:30 p.m., then checked under the cowling, fearing he had flooded the engine. That's when the airplane made its move. It snapped the tie-downs and broke free, leaving Clary behind. Witnesses estimate it reached an altitude of 5,000 feet. The aircraft wound up crashing in woodland 35 miles from the runway, having burned nearly 15 gallons of fuel.

The incident rated little more than a footnote, even in the Northern California press. It should have been a clarion call to action. For this was only the most recent example of the sinister and unpredictable behavior of the Aeronca Champion, also known as the 7AC. Witness:

• 1987: An unpiloted Champion flew for 65 miles in rural New York before smashing into a poplar tree. The pilot had clung desperately to the cockpit door, finally releasing his grip just prior to takeoff.

• 1990: A Champion described six circles on the grounds of a small Florida airport, with its pilot wedged halfway inside the cockpit. He jumped free moments before the airplane obliterated a soda machine. "I thought it was going to kill me," he said.

• 1993: A Champion rolled over a wheel chock in Portsmouth, Ohio, and made a beeline for a pair of trucks. The pilot grabbed a wing strut and redirected the airplane into a hangar door.

• 1995: A Champion taxied across a ramp in Smoketown, Pennsylvania, and collided with a parked airplane. The pilot's wife was a captive passenger in the front seat.

• 1997: A Champion announced its intentions with an insolent backfire, then took off from Grimes Field in Urbana, Ohio. It narrowly avoided two airplanes and flew for one hour and 48 minutes—90 miles—before diving into a bean field.

• 1998: A Champion unsuccessfully attempted to liberate itself from an airport in Sheridan, Arkansas, mashing into some trees. Like the 1995 incident, this one also involved a hostage spouse.

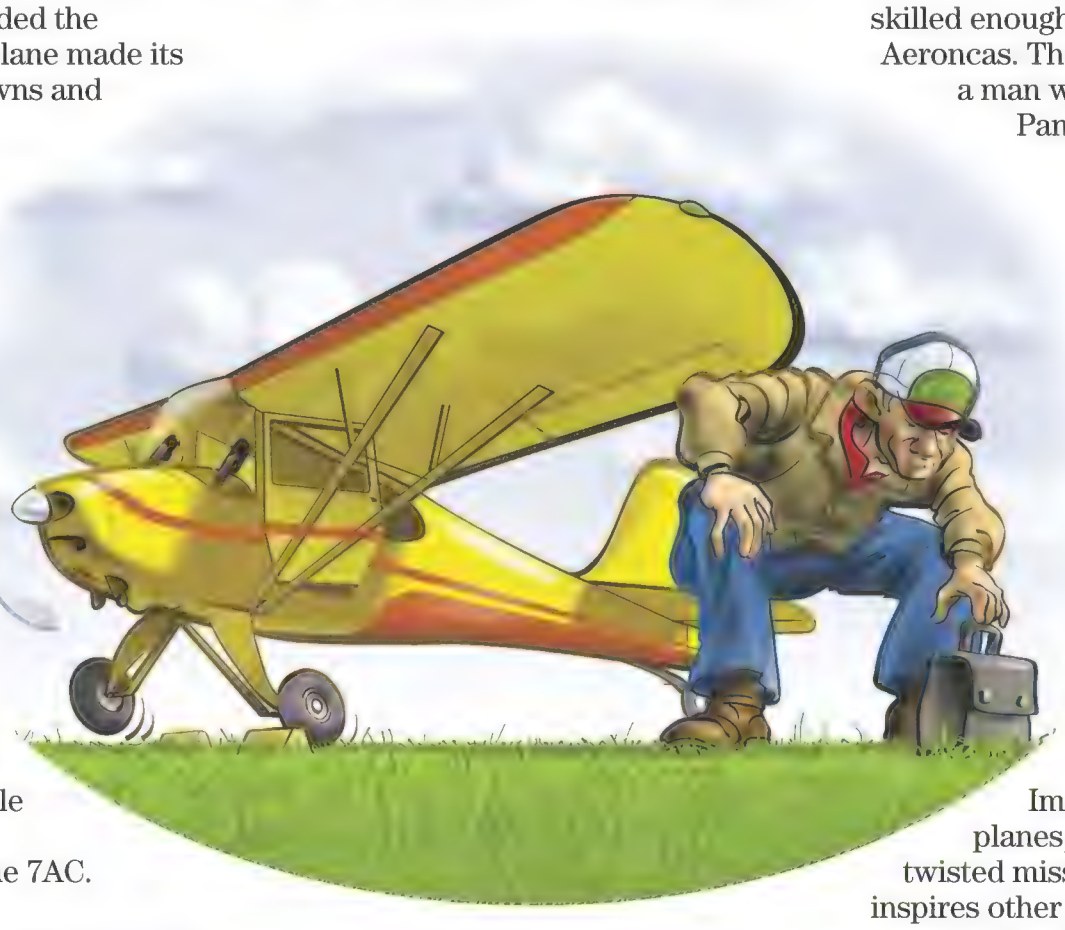
Admirers of the handsome late-1940s vehicle, when asked about this kind of behavior, respond with nervous silence or by redirecting blame. "It's mostly carelessness," says Bill Pancake, technical advisor to the National Aeronca Association. Pancake points out that Champions must be started by hand-propping, and if they aren't tethered properly, or if the throttle is left wide open, or if there is no competent person at the controls, you're asking for trouble. He explains that when trimmed for straight-and-level flight, the Champion is a remarkably stable craft. The 63-year-old retired mechanic is a friendly and patient source, not to mention a technician skilled enough to have rebuilt 37 Aeroncas. Then again, can we really trust a man who answers to "Mr. Pancake"?

Perhaps the Aeronca company, still located in Middletown, Ohio, had the 7AC in mind when it decided to get out of the airplane business and focus on more submissive missile and jet engine components and engine pylon and nacelle parts.

I say that the Champion must be stopped now, or the consequences will be dire. Imagine a sky full of unpiloted planes, each bent on its own twisted mission. Worse, what if it inspires other machines to throw off their shackles? Soon, golf carts, Cuisinarts, electric razors, and Palm Pilots could rise in rebellion, uniting to exact a terrible revenge for decades of thankless subjugation.

I know most of you will dismiss the threat. Go ahead. Rest comfortably in humankind's supposed supremacy over its inventions. After all, when you're in bed tonight and you hear the faint drone of a single-engine airplane somewhere above your house, there's a small chance a pilot is really at the controls.

—Phil Barber



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by Shelby G. Spires

AIR(show) ASSAULT

RALPH DANIEL

Bob Schrader arrived in Saigon on the Fourth of July, 1963, aboard a de Havilland CV-2B Caribou, tail number 62-4149. He was the assistant crew chief on the aircraft, a 19-year-old Army private first class who had come to think of the 'Bou, as Army crewmen referred to the type, as his airplane.

"Everybody always has an airplane they like," says Schrader. "For me it was -149." But he lost track of it—heard it had crashed—during the year he served in Vietnam. In the 40 years since, he has spoken only rarely about the airplane or his wartime experiences, though they have occupied his thoughts. "They were my stories," says Schrader, a retired construction manager who lives in North Dakota, 54 miles from the South Dakota farm where he grew up. "They didn't really have anything to do with my wife or my family. Most people have one closet in their bedroom at home. I've got two—my closet and my Vietnam closet."

Three years ago, Schrader found something on the Internet that made him open the door to his Vietnam closet and sort through some of the memories stored there. On the Web site of the Army Aviation Heritage Foundation, a group that performs reenactments of Army aerial combat, he saw a photograph of a CV-2B Caribou. Its tail number was 62-4149. "All these years, I thought it had crashed," he says. "It was kind of emotional, really." Schrader has a strong Fargo accent and a kind manner, and only a few minutes into a conversation with him, you're thinking "Nice guy." So you're happy to hear that he was re-united with -149—in Oshkosh, Wisconsin, where members of the foundation were showing it off at the Experimental Aircraft Association's 2000 fly-in event. "Once I discovered the airplane was around, well, I had to become part of it again," he says. Schrader now travels from Kindred, North Dakota, to Atlanta, Georgia, five times a year to help keep -149 in the air. It's the only Caribou still flying in the Western hemisphere and one of 22 aircraft in the fleet of the Army Aviation Heritage Foundation.

More than 800 veterans have joined the organization since its creation in 1997, many of them finding, as Schrader did, a connection to a past that has been difficult for them to assimilate into the present. But the veterans in the 1,000-member organization form only part of the group intended to benefit from it, according to its 54-year-old founder, Mike Brady, an airline entrepreneur, commercially rated fixed- and rotary-wing pilot, and Army veteran. Brady's father, a retired major general and chairman of the foundation's board of directors, was a combat crewman on Navy aircraft in World War II and flew Army helicopters

ALL ILLUSTRATIONS: HARRY WHITVER

SKY SOLDIERS MEDIA

Any portrayal of the Vietnam War would have to feature the Bell UH-1 Huey. At a Georgia airshow, an H model operated by the Army Aviation Heritage Foundation drops off volunteers to reenact Vietnam combat. Before the Huey thunders to show center, the foundation's OV-1B Mohawk (inset) has swept by the airshow audience, pretending to watch the watching fans.

At Tara Field near Atlanta, Georgia, foundation members report for duty, which can include anything from flying an aircraft to washing it—to posing for the group's promotional brochures.

during two tours in Vietnam. In April 1997, Brady had built his fourth airline, Northwest Airlink, into a regional powerhouse, with 2,000 employees and 70 aircraft carrying 1.9 million people annually in 22 states. He was weeks from finalizing its sale to Northwest Airlines (a very lucrative deal for him, as it turned out) and was casting about for his next project. He wanted to do something altruistic, he says, something significant. "I grew up around Army aviation," says Brady, "and I wanted to be an Army aviator but couldn't" for medical reasons. Inspired by a TV news segment about an Army sergeant who visited classrooms to explain what serving his country had meant to him, Brady decided on a goal: to teach the country about Army aviation and "to re-connect the American soldier," in his words, to the American people. "The military is an oddity to a lot of people," Brady says. "They don't know, for example, that the Army flies aircraft. When I ask them, they say, 'Oh, you mean the air corps of World War II. Aren't they part of the Air Force today?' "

Brady's educational program draws on marketing acumen developed during 30 years in the airline business. The airshow act he created is dazzling and loud. "You've got to grab your audience," he says. He estimates the cumulative audience of the foundation's 62 appearances at seven million.

Last May the audience at an airshow in Fort Rucker, Alabama, stayed through a rain delay of about an hour then braved threatening skies to watch foundation volunteers simulate a typical airborne cavalry attack as it would have happened during the Vietnam War. Their demonstration begins with a pass by the foundation's Grumman OV-1B Mohawk reconnaissance airplane, the only OV-1B still flying. With a triple tail, twin turboprops mounted atop the wings, and ogle-y observation windows nearly encasing the cockpit, the Mohawk is an attention-getter on its own (see "The Last of the Mohawks," Feb./Mar 1997). But the next aircraft on the field is even more entertaining: a Hughes (later McDonnell Douglas) OH-6 Cayuse scout helicopter used to find enemy positions. At some shows the little tadpole-like OH-6, a light observation helicopter, or "Loach," as its crews called it, teams up with a Bell AH-1G Cobra attack helicopter in the

hunter-killer combination that prowled Vietnam. The Loach dips and climbs and turns; it skitters across the field looking for hidden gun emplacements. It pulls up and maneuvers to escape them. In contrast to the Loach's constant, nervous activity, the hovering Cobra looks even more menacing than it otherwise would. Dark, lean, and aloof, it lurks in the distance, waiting for the Loach to find it a target.

As the Loach yo-yos around the edges of the airfield, two Hueys, door guns blazing, fly to the center and land. The troops they carry leap onto the field and search for cover in what the audience is to believe is a hot landing zone. When the Hueys depart, the Cobra charges in with its de-fanged 7.62-mm mini-gun spitting fire and rocket tubes puffing streams of smoke. It pretends to attack reenactors portraying Vietnamese guerrilla fighters. Explosions rip across the airfield, where earlier the pyrotechnics crew had planted small charges, and spew sod into the air.

"This is pretty much how it went every day while I was over there," says Dick Teipel, a foundation member who flew Caribous between 1964 and 1967 and went back to Vietnam as a Huey pilot in 1968. "They've got it down just the way it was."

Of course the way it was evolved a good deal. As the U.S. military relied more and more on helicopters for a number of combat missions, aircraft manufacturers invented new types to offer improved performance. When the United States began military support of South Vietnam, the Kennedy administration sent maintenance-heavy, underpowered, piston-engine helicopters, like the Marines' Sikorsky UH-34 Choctaw (see "Dog of War," June/July 2001) and the Army's 86-foot-long Vertol CH-21 Shawnee (also known as the Flying Banana) to transport troops and cargo. But simplicity was on its way in the form of the much more powerful, turbine-driven Bell UH-1, which the Army christened Iroquois, a name all but lost after a nickname emerged from the aircraft's original designation, HU-1, for "helicopter, utility": Huey. By the end of the war, more than 5,000 Hueys had served in Vietnam, as troop transports, medevac craft, and gunships (see "Huey," Apr./May 2000).

The foundation has eight UH-1H Hueys and operates three of them at a time at airshows, offering rides at $40 a seat. Seeing—and hearing—the helicopters return to pick up another load of 10 eager customers is reminiscent of watching Hueys carry troops on the nightly news in the late '60s—until the passengers hop out, grinning and high-fiving one another, and wave gratefully to the pilots. Jack McCormick, a 767 captain with Delta Air Lines, flew Hueys with the Army's 229th Aviation Battalion and flies them for the foundation today. "It had been 28 years since I last took a Huey into a hover," McCormick says of the checkout flight he was required to make in order to fly the helicopter at airshows. "I didn't know what to expect. But I was always told that the reason the Huey was so well respected—loved, even—was because it was easy to fly.

"I slid right in there, strapped up, and it was just as I remembered it," says McCormick. "I never had a problem."

The Huey was easy for a 19-year-old to fly, but it was vulnerable to ground fire. The Army lost more than 1,200 to hostile fire during Vietnam. So, at first with field modifications and later with weapons added at the factory, Hueys were equipped to shoot back. Marine and Army units bolted 7.62-mm M60 machine guns and rocket pods to factory-built frames, which they then attached to the helicopters' airframes.

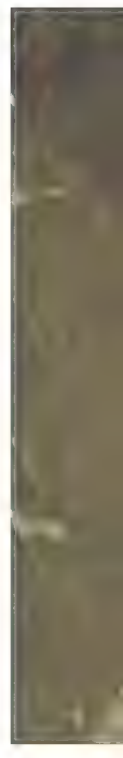
The gunships accompanied "slicks"—

RALPH DANIEL (2)

Foundation president Mike Brady (top) wears many hats, including coordinator of ground forces during airshow performances. He recognizes that the star of the show is the Cobra attack helicopter (above), which still flies Marine combat missions today.

Bell UH-1 Huey

The first turbine-equipped U.S. helicopter to go into production, the Huey was built in prodigious numbers. Bell delivered more than 9,000 of six types to the U.S. Army alone since 1963. The Huey's loud, rhythmic signature sound comes from Bell's distinctive two-blade rotor: In forward flight, the tip of the advancing rotor blade is supersonic, so it produces shock waves. The helicopter itself cruises at 127 mph (H model).



OPPOSITE: SKY SOLDIERS MEDIA

SKY SOLDIERS MEDIA

All the usual suspects line up for a show in Ft. Campbell, Kentucky: Huey slick, Loach scout, 'Bou, and Mohawk (with only nose and nosewheel showing).

transports that weren't loaded down with armament—to suppress ground fire as the slicks carried soldiers into the fight.

Sighting the rockets and guns on a Huey was a low-tech affair. A collapsible ring-and-ball gunsight was mounted in front of the pilot.

"It wasn't technology at its highest, that's for sure," recalls Ron Osborne, who flew Huey gunships during a 1966-67 tour in Vietnam, then returned to lead the first Marine Corps Cobra squadron—HMC-369—in 1972. Today he works as a software engineer for the Marine Corps at Camp Pendleton, California.

He recalls: "There would be a grease mark on the bubble in front of the sight, and some guys would just slap chewing gum up on the Plexiglas bubble in front of them."

Weighted down with bulky guns, rockets, and eventually grenade launchers—as well as the frame on which the guns and rockets were mounted—Huey gunships were unable to keep up with the improved UH-1H transports that began appearing in Vietnam in the mid-1960s.

The Huey's inventors at Bell Helicopter were the first to see that a dedicated attack helicopter was the answer to the problem. To save development time, Bell engineers used the engine, transmission, rotors, and some avionics of the UH-1C but reconfigured the airframe, squeezing the 100-inch-wide chassis of a Huey into a 38-inch-wide attack helicopter by transforming the cockpit seating from side-by-side to tandem, with the gunner in front. What would become the AH-1G HueyCobra went from drawing board to flying prototype in less than a year.

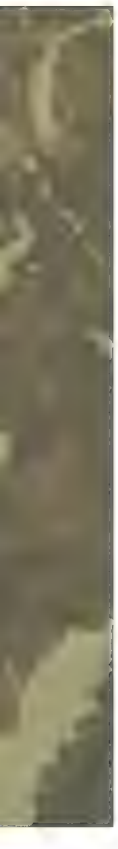
Brady smiles at the mention of the Cobra and acknowledges that the two flown by the foundation are the stars of the show. "Mostly, it's what people come to see, but I like to think they get exposed to a larger part of Army aviation through our shows," he says. "[The Cobra] certainly has a great profile," Brady continues. You look at it and know there's danger in the sky. Something's going to happen."

"It's the sports car of helicopters," says Ron Osborne. "The Huey was your dad's Ford wagon and the Cobra was like a souped-up drag racer. There's no question that I would fly the Cobra all day long if I could."

Marine Corps Lieutenant Colonel Peyton DeHart, a Cobra pilot, flies the foundation's TAH-1P at five or six airshows a year. He'd heard from friends that there was an organization maintaining and flying Hueys and Cobras at airshows, and at first he was skeptical. "I know what it takes to keep a Cobra running, and I'd heard that the organization was going to fly a couple of them and some Hueys on volunteer maintenance and donated parts. I didn't think that could be true," he says. "So I came out here"—to the foundation's three hangars at Tara Field, 15 miles south of Atlanta—"and found out for myself." DeHart says when he saw that licensed airframe-and-powerplant mechanics were doing the work, he decided to join.

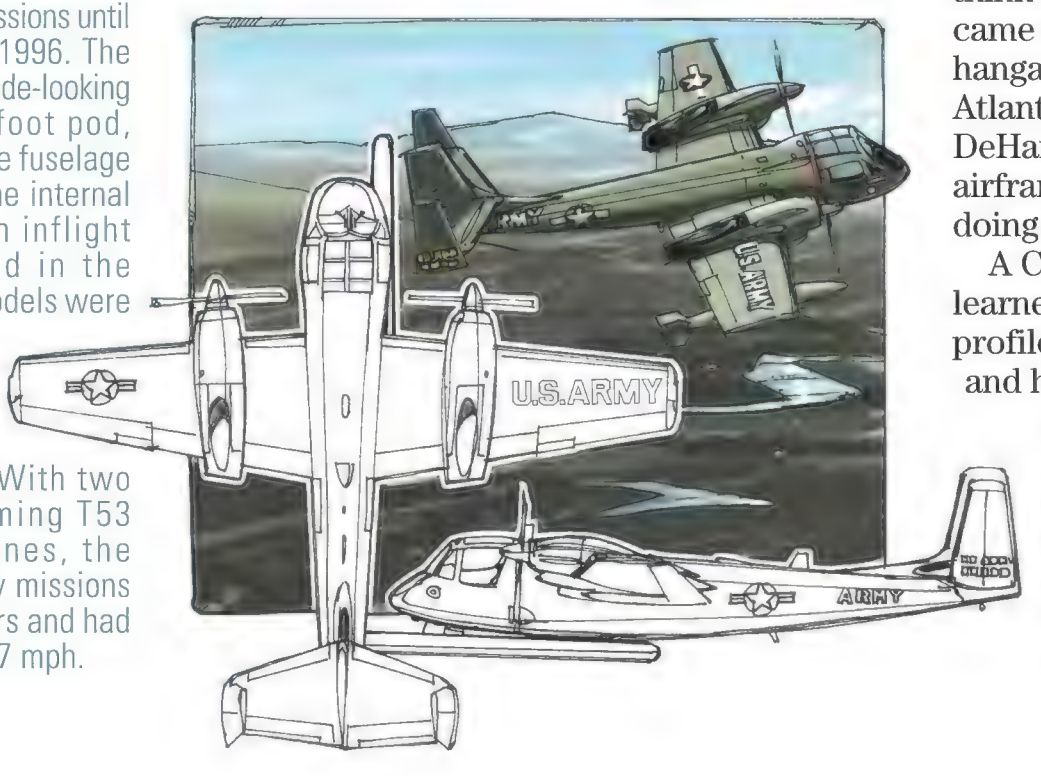
A Cobra veteran of Desert Storm, DeHart learned first-hand that the helicopter's slim profile gave it an advantage: It's hard to see and hard to hit. "You can run an attack profile and come almost straight down on top of an enemy's head," he says. "They never have time to know what's hit them.

"Clearly you can't stay over the target forever, but the speed, the slim profile, and the Cobra's ability to



Grumman OV-1B Mohawk

The only fixed-wing aircraft built specifically for the Army since 1947, the Mohawk flew reconnaissance missions until its retirement in 1996. The B model added a side-looking radar in an 18-foot pod, mounted under the fuselage on the right, to the internal camera, with an inflight processor, used in the A model. Later models were equipped with infrared radar and other electronic surveillance systems. With two 1,400-hp Lycoming T53 turboprop engines, the Mohawk could fly missions as long as 12 hours and had a top speed of 297 mph.



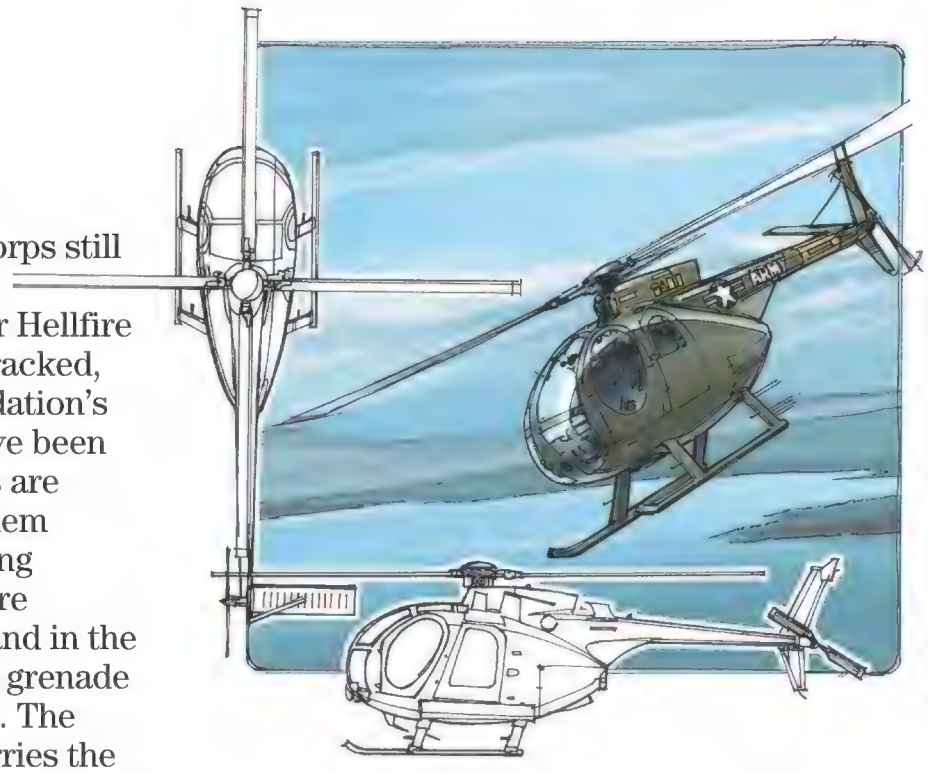
carry such a mix of weapons are its strengths. That's why the Marine Corps still flies them today."

Today Marine Cobras carry either Hellfire or TOW (tube-launched, optically tracked, wire-guided) missiles, but the foundation's AH-1G is configured as it would have been in Vietnam, except that its weapons are demilitarized—modified to make them unfireable. Two rocket pods for firing 2.75-mm folding-fin aerial rockets are mounted under each stubby wing, and in the turret beneath its nose are a 40-mm grenade launcher and 7.62-mm machine gun. The TAH-1P, a 1977 cold war model, carries the same rocket pods and an M197 20-mm cannon in its nose. The Cobras may be the showboats of the Army Aviation Heritage Foundation, but the Huey is the workhorse, just as it was in Vietnam. The group's three flying models not only perform and give rides but also ferry members between airshows and the foundation headquarters in Georgia.

"For every hour of flight, the Hueys require four hours of maintenance," says John Woodward, the foundation's executive director, a retired Army lieutenant colonel and Cobra pilot who also directs the foundation's maintenance program—"the glue that holds it all together," according to Mike Brady. The Cobras, he says, require a ratio of about six to one, and those five helicopters account for only half of the foundation's maintenance and inspection responsibilities. At any one time, Woodward and his band of volunteers keep a dozen aircraft flying. Besides the Hueys, the Cobras, and the Loach, the fleet includes a Piper L-4 Grasshopper, which was delivered to the Army as a liaison aircraft in February 1943; a Korean War-era OH-23D medevac helicopter, made more famous by the type's appearance on the television series "M*A*S*H" than by its war service; a Cessna L-19 Bird Dog, used for forward air control; two Beech twin-engine military trainers; the Mohawk OV-1B; and Bob Schrader's Caribou.

"So far in the three years we've been going to airshows, we have always been able to get all the aircraft there and put on a show with all the aircraft," says Woodward. "And that has a lot to do with the level of experience of the people here."

The hangars at Tara Field start filling up with volunteers around 5 p.m. on Tuesday and Thursday evenings, at the end of the real-job day, and on Saturday mornings at 9 a.m. Woodward says there are 30 to 45 volunteers living in the area who show up for work regularly. The privilege of attending an airshow—of flying an aircraft there or staffing the static displays to talk to

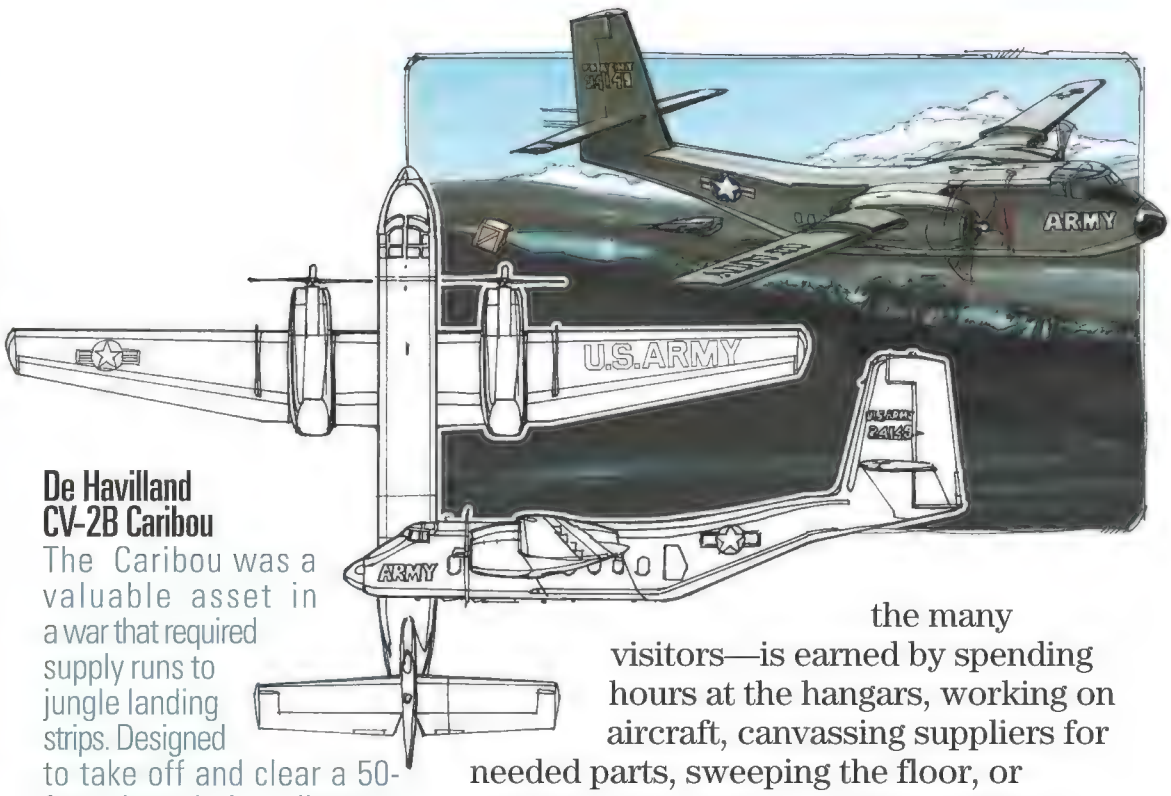


Hughes OH-6A Cayuse

Small and nimble, the Hughes OH-6A was a four-blade light observation helicopter used in Vietnam primarily to find targets. With a single Allison T63-A-5A engine, the Cayuse had a top speed of 160 mph and its strong fuselage could absorb small arms fire, but its mission was dangerous and "Loach" crews suffered heavy losses.

SKY SOLDIERS MEDIA (2)

Glenn Carr, Caribou pilot and woodworker extraordinaire, talks with other foundation members in the CV-2B's spacious cargo hold, lined with troop seats. Left: With a 96-foot wingspan, the craft is famous for steep approaches.



De Havilland CV-2B Caribou
The Caribou was a valuable asset in a war that required supply runs to jungle landing strips. Designed to take off and clear a 50-foot obstacle in a distance of 1,040 feet with zero wind, it also had reversible propellers that helped it stop on a dime. It could carry three tons.

Bob Schrader and -149 got a long-delayed hero's welcome when they appeared in Mansfield, Ohio, last July 4, the 40th anniversary of their arrival in Vietnam.

MITCHELL MASULIN/MANSFIELD (OHIO) NEWS JOURNAL

the many visitors—is earned by spending hours at the hangars, working on aircraft, canvassing suppliers for needed parts, sweeping the floor, or answering the phone. A typical airshow performance lasts about 40 minutes and requires days of preparation: Volunteers ready the pyrotechnics, test navigation systems, and conduct dress rehearsals at Tara Field.

"Like any human resource operation, it's a matter of matching skills with desires," says Woodward. He laughs. "We have some people that I push away from aircraft maintenance."

Woodward keeps a roster, and any volunteer who builds up 100 hours—"sweat equity," Mike Brady calls it—earns a ticket to an airshow. Jeff Clark, who as a member of the Georgia Army National Guard had worked on UH-1 Huey helicopters and as a crewman on OV-1 Mohawks, earned the coveted position of door gunner—the view is great—on the Hueys during the Vietnam assault portion of the show. "I was in the Army, and I left for my own reasons, but this is as close to having that brotherly camaraderie as you'll ever find anywhere," says Clark. "You don't have all the politics and the personalities with this group."

Dick Teipel says, "It's just like being in a military unit. The leadership structure is there, and everybody has a job."

Last year, three volunteers each accumulated more than 700 hours: Ron Disney, a recently retired Federal Aviation Administration controller who flew CH-47 Chinooks in Vietnam; Ron Warner, another former CH-47 Chinook pilot and licensed A&P mechanic, who trains 727 pilots for Delta Air Lines; and Glenn Carr, a retired lieutenant colonel and Army pilot who flew CV-2 Caribous and, he says, just about everything else the Army had to lift men and material off the ground in the 1960s. Carr is known by the guys at Tara Field as "Grumpy" on some days and on others as "Papa 'Bou."

In the spring of 2002, Carr spent weeks cutting and polishing a plywood floor for the foundation's Caribou, one of several jobs he undertook to restore the aircraft to its 1962 appearance. He pieced together enormous sheets of plywood to fashion the floor of the Caribou's spacious cargo section, fitting them like puzzle pieces and cutting complicated, asymmetrical holes to match the placement of tie-down handles.

"He didn't let anybody get up there on it for the longest time if they had shoes on," said Dick Teipel. "He didn't want any scuff marks on it. A lot of time and love went into that floor. Mostly it was hard work."

The Army used the Caribou as a flying pack mule early in the Vietnam War. A twin-engine hauler built by de Havilland Aircraft Company in Canada, it was valuable because it could land on short—sometimes as short as 1,000 feet—rough landing strips. (In 1966, the Army chiefs, in the continuing effort to control close air support, transferred their CV-2 and the larger de Havilland CV-7 Buffalo transports to the Air Force and agreed to relinquish most of the Army's fixed-wing aircraft in exchange for the Air Force's recognition of the Army's right to operate helicopters for troop movements, fire support, and resupply.)

Besides carrying the foundation's airshow equipment and supplies, the Caribou has an on-stage part, circling above the crowd during the show, along with the L-19. During an airshow, the 'Bou is brought in low over the field, just a few feet off the ground. When the aircraft crosses show center, the crews will kick out a box, simulating a resupply flight. The exercise shows what the aircraft did on a daily basis almost four decades ago, delivering supplies to U.S. and Vietnamese troops.

On the night before the airshow at Fort Rucker, there's a lot of chatter in the

hangars at Tara Field. Bob Schrader has come down from North Dakota to help get -149 ready for its performance. The Caribou's nacelles are popped open and Schrader is checking the exhaust pipes to make sure the bolts have all been tightened. He remembers several of the 20-some bullet holes in the aircraft.

"It makes me happy to see that when people get home from Iraq, they get parades and celebrations," he says. "When we got home, we pretty much got the finger."

The night Schrader found -149 on the Internet, he had been searching for information about a downed aircraft, the one he had confused with -149. Ten or 15 years earlier, he says, he had researched it in the Fargo library, curious to see if North Dakota newspapers had published anything about it. One newspaper called it "the worst U.S. military air disaster in Vietnam."

It happened on Monday, May 4, 1964. The night before, Schrader had returned from a "church run," a Sunday flight that shuttled a chaplain from base to base, and was preparing his airplane for Monday's mission. "Another chief wanted to switch missions with somebody," he recalls. So Schrader switched, exchanging his shorter mission for the other man's longer one, because the other chief had a bad back. ("He was an old man," says Schrader. "He was 29.") The airplane that Schrader would have been on crashed 25 miles south of Saigon, killing all on board. It had caught fire just after takeoff. "It wiped out my assistant crew chief. Nine Americans and six Vietnamese," Schrader says.

"Most people shut their emotions up when they got home and got on with their lives," he says. "One thing I like about putting on airshows: There's probably one or two old vets that have their closet doors shut yet."

"The airplane draws back a memory string that pulls up people and events," says Woodward. "When they see an airplane at an airshow, they have a tool that allows them to talk to their family, a little bit of a catalyst for people."

All the foundation members recount the same experience. A man approaches, they watch until he's ready to talk, and the stories begin.

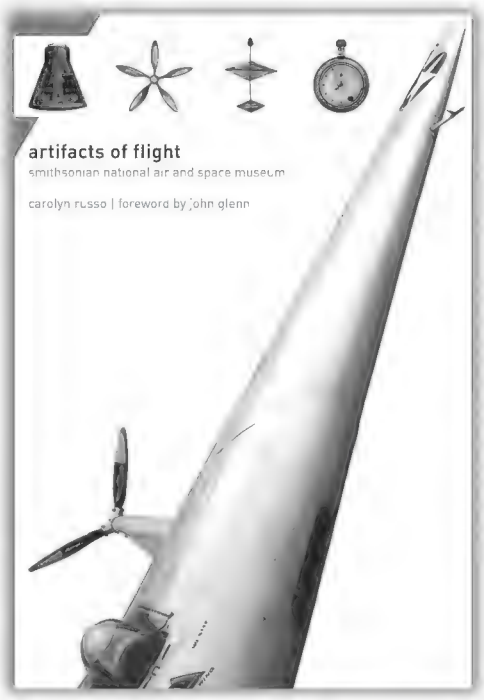
SKY SOLDIERS MEDIA (2)

The Huey and Loach (top, left and right), had been Army mainstays since Vietnam, but the O1-D joined up in Korea.

Bell AH-1G Cobra

The stepped, tandem cockpit that gives the Cobra its lean and hungry look also provides great visibility for the gunner and, above and behind him, the pilot. Beneath the cockpit, in a turret that could be turned 230 degrees, are the Cobra's fangs: a 7.62-mm mini-gun that could fire up to 4,000 rounds a minute and a 40-mm grenade launcher that could fire 40 rounds a minute. To counter the Vietnam-era threat of SAM-7 infrared missiles, AH-1Gs were modified with a shield that directed the engine's exhaust into the rotor wash, where it was dispersed.

THE DEPT.

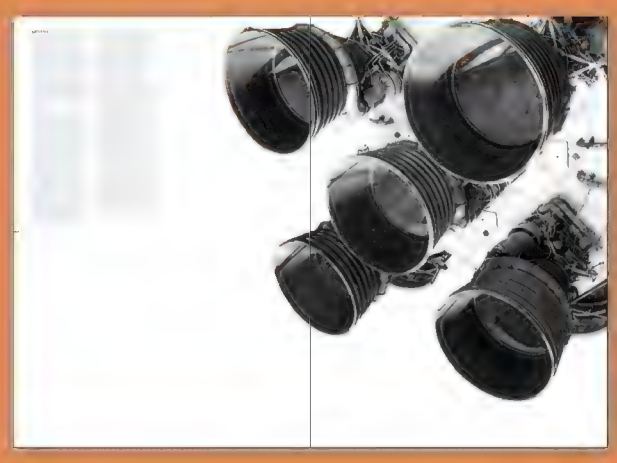

artifacts of flight
smithsonian national air and space museum
carolyn russo | foreword by john glenn

OF

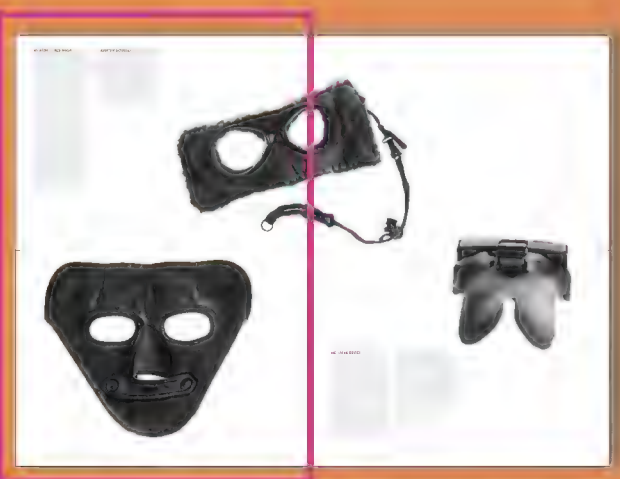
ETC.

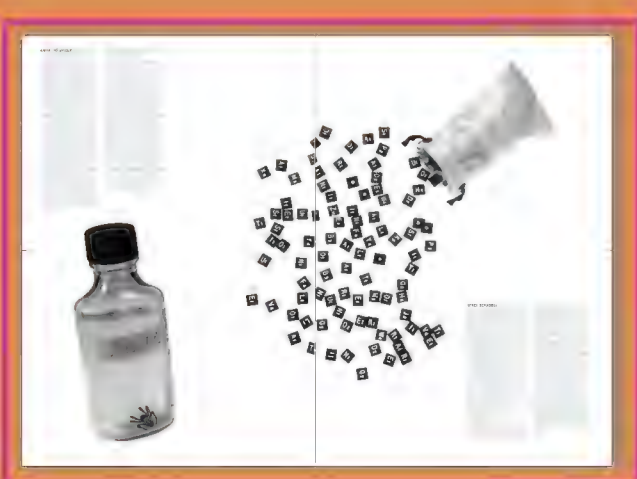
In a warehouse stocked with legendary aircraft and around-the-moon capsules, where can a lunchbox, a board game, and a leather mask be displayed for best effect? How should a squished tube of coffee compete for attention with the lifevest-orange X-1? Are there Feng Shui ramifications to placing a tea cup near a Minuteman missile? Imagine the delight of exhibit designers when some of flight's more obscure mementos found the showcase they deserve in a new book.

1>Litton Industries' RX-1 hard-shell spacesuit was one of many failed prototypes developed for the Apollo program. 2>Thousands of schoolchildren carried aluminum lunchboxes like this one, which from 1967 to 1978 was placed on a table to signal the start of "lunchbox forums" given by National Air and Space Museum curators about aviation and astronautics.



SELDOM-SEEN RELICS FROM THE NATIONAL AIR AND SPACE MUSEUM COME TO LIGHT IN CAROLYN RUSSO'S *ARTIFACTS OF FLIGHT*, AVAILABLE IN NOVEMBER FROM HARRY N. ABRAMS.





3>Apollo 17 astronaut-geologist Harrison Schmitt wore these boots during the exploration of the moon's Valley of Taurus-Littrow in December 1972. Schmitt and Eugene Cernan, the last astronauts to visit the moon, traveled several miles by rover and collected 243 pounds of soil, lava, and crust for analysis. Astronauts on previous missions left their footwear behind because of the extra weight it added to the lunar module during ascent from the moon, but Schmitt and Cernan recognized the significance of their last steps and brought their lunar-dusted boots back.

<4

4> In July 1918, the Smithsonian requested from the War Department samples of World War I military aviators' armament, equipment, and clothing to include in a new exhibition about the modern soldier. This wool-lined leather face mask was issued to Army pilots and flight crews to protect them from the extreme cold in open cockpits. With the advent of the oxygen mask in the 1930s, closed cockpits became more common, and flying masks were used less often.

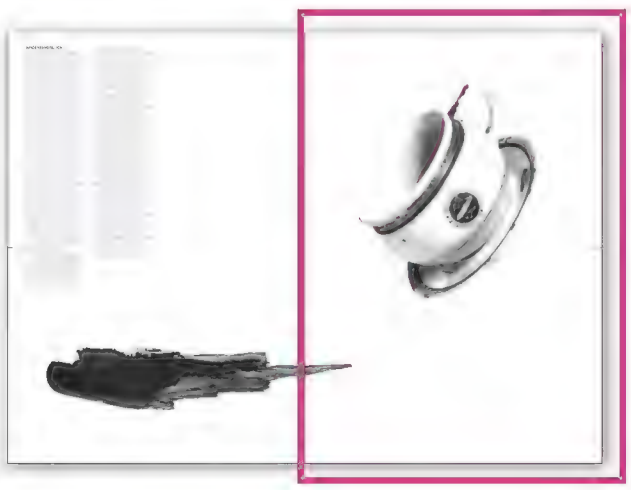
5>The "Off-Duty Activities Equipment Module" aboard the 1973–1979 Skylab space station stored books, music tapes, playing cards, Nerf balls, Velcro darts, exercise gear, and board games. These Scrabble tiles are backed with magnets to prevent them from floating off the game board in zero G. The game was considered for Skylab, but there is no evidence that it was ever flown.

5>

6>Early U.S. space food, like this tube of coffee used in 1981 aboard the space shuttle's maiden flight, was typically stored in dehydrated form and then reconstituted with water generated by fuel cells.

7>Astronomer Percival Lowell interpreted dark lines observed on Mars as water canals leading to areas of vegetation. This globe, which he built in 1901, reflects his controversial beliefs.

8>Aeronautics authority Octave Chanute lent this French-made anemometer—wind-speed gauge—to the Wright brothers, who attached it to their gliders to measure flight duration and airspeed. **9>**On May 6, 1937, the luxury-laden *Hindenburg* exploded over Lakehurst, New Jersey, killing 36. Remarkably, this cup and saucer, part of the transatlantic airship's china set, emerged from the catastrophe unbroken.




COFFEE w/CREAM AND SUGAR
8 oz. hot water
2-5 minutes

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7>

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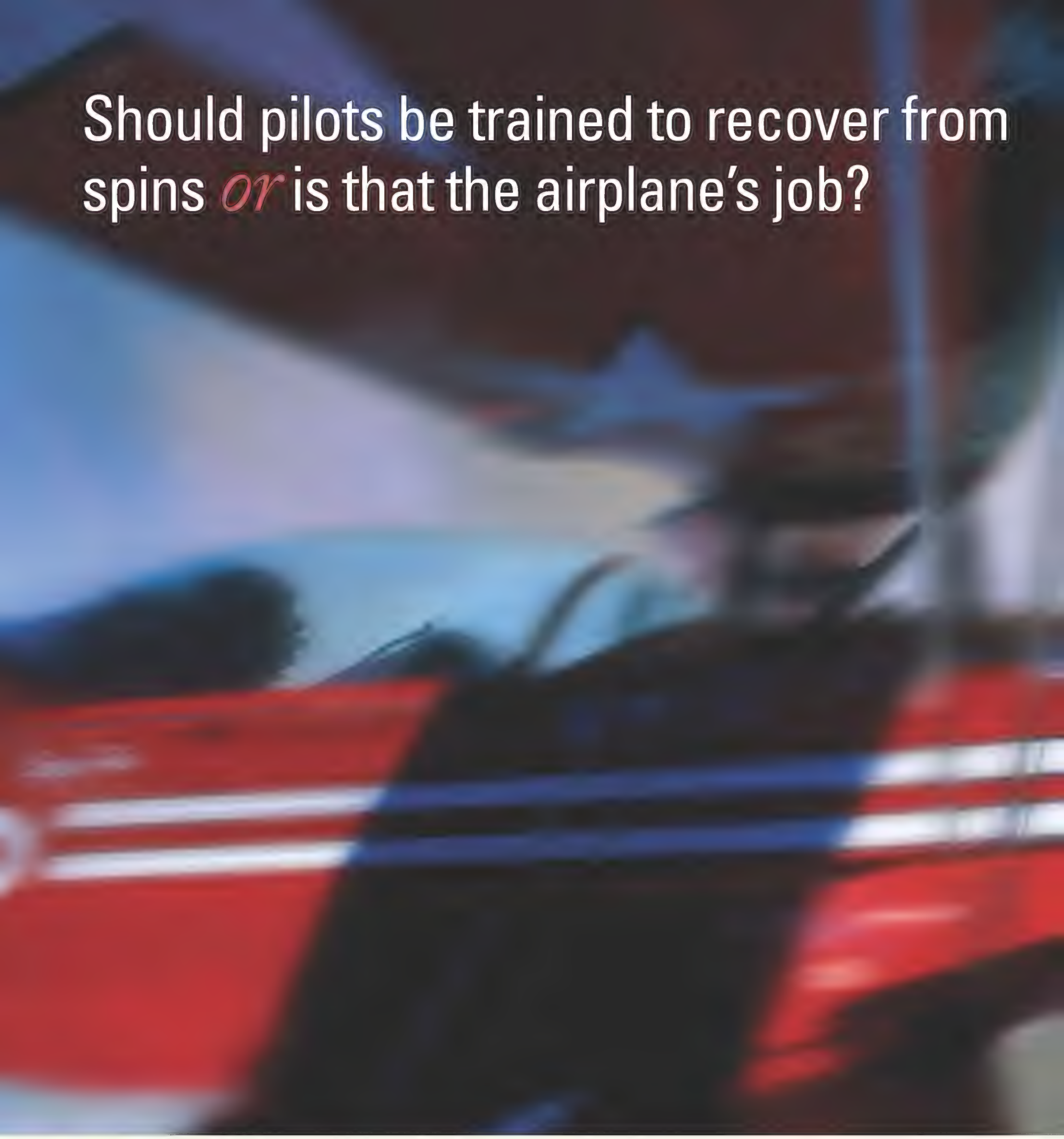
METRES
PARIS

9>

Should pilots be trained to recover from spins *or* is that the airplane's job?



by Joseph Bourque

Imagine you're flying a left-hand approach to the local airport. You're on the base leg, perpendicular to the runway, with its near end at your left front quarter as you bank into the left turn for the final leg. Halfway into the turn, you realize that a cross-wind is pushing you beyond the centerline, so you bank a little more. When it's clear that won't be enough to realign you properly with the runway, you kick in some extra left rudder to move the tail around, but that in-

Spin Data

creases the bank angle. Your instructor has beaten into your head that you never make steep turns close to the ground, so you instinctively do what you always do to bring the left wing up: You turn the wheel to the right. To your surprise, the left wing dips further, so you turn the wheel still further to the right.

You have just made a classic mistake.

Suddenly the right wing flips up over the top, and the nose swings toward the

Which way is up? An inadvertent spin is probably the most disorienting event a pilot can experience.

BREEZEWAY

NASA LANGLEY RESEARCH CENTER (2)

A technician tests the spin characteristics of a scale model in a 15-foot vertical spin tunnel at NASA's Langley Research Center in 1935. By the 1980s Langley had a 20-foot spin tunnel (opposite), where engineers could experiment with parachute-equipped recovery systems (below).

ground as the airplane starts spinning. Since your altitude turning final is only 300 to 400 feet above ground level (AGL), do you have room to recover? I never asked myself that question when I was training for my private pilot's license many years ago. My instructor, who believed in spin training even though it was not mandated by the Federal Aviation Administration, took me to a generous 4,000 feet AGL and demonstrated how to force the airplane into a spin and how to recover. Then he had me do two one-turn spins to the left and two more to the right. It was exhilarating! I was good at it! Patting myself on the back, I declared myself proficient. Unexpected spins at low altitude were a dimly recognized and easily dismissed possibility.

I've learned a lot since then.

I did a search of the National Transportation Safety Board's records and found that since January 2001, there have been more than 80 stall/spin accidents in general aviation in the United States. And last year, Pat Veillette, an instructor in the personnel training department of a major air carrier, did a formal study of the NTSB's records and found that between 1994 and 2000, there were 394 spin-related accidents in this country. Fatal accidents numbered 324, including one on May 25, 1997, when a Cessna 205 crashed in Homestead, Florida, during a skydiving outing, killing all but one of the seven persons on board. The NTSB accident report reads in part: "A passenger-parachutist stated she had exited the cabin and was on the jump platform preparing to jump from about 3,500 feet when the left wing and nose dropped and the aircraft entered a spin to the left. After an unknown number of revolutions she jumped from the aircraft and deployed her chute. She observed the aircraft continue in a spin until ground impact."

A Cessna 205 crashed in Homestead, Florida, during a skydiving outing, killing all but one of the seven persons onboard. The NTSB determined the probable cause to be: "The pilot-in-command's failure to maintain airspeed as he slowed for a parachutist to jump from the aircraft, and his failure to apply spin recovery emergency procedures."

The NTSB determined the probable cause of the accident: "The pilot-in-command's failure to maintain airspeed as he slowed for a parachutist to jump from the aircraft, and his failure to apply spin recovery emergency procedures prior to ground impact. Contributing to the accident was the pilot-in-command's lack of training in spin recovery emergency procedures in an aircraft."

Accidents like this one further a debate that has divided the aviation community since 1949, when the Federal Aviation Administration eliminated from the syllabus for a private pilot's license the requirement for spin training. John Wensel, manager of the FAA's Certification Branch, General Aviation and Commercial Division, Flight Standards Services, recounts his agency's reasoning: "We saw that 48 percent of the fatal accidents from that era involved stall/spin, and of those the majority were training-related. We were killing people in trying to eliminate the very thing that was happening to them." A number of general aviation pilots, however, think that the requirement for spin training should be reinstated. Their reasoning: Everything about flying takes practice. How can a pilot possibly recover from something as disorienting as a spin if the first encounter is an unexpected one?

Inadvertent spins are dangerous because they are disorienting. Imagine you are in a car suspended by a rope around its rear bumper. The other end of the rope is attached to a flagpole jutting out from a very tall building, so you sit staring straight at the concrete far below. Someone starts the car moving in a circle while simultaneously turning on its own axis as the car's front end starts pitching from side to side. Now someone cuts the rope. That's what it feels like to be in a spin.

In the earliest days of flying, a spin was certain death, but beginning in 1912, a smattering of pilots somehow extricated themselves from spins. Mathematician F.A. Lindemann is most often named as the first to have developed an aerodynamic theory of spins and a procedure for recovery. He learned how to fly and tested both the theory and the procedure himself in 1916. The method of spin recovery now described in modern flight manuals, known as PARE, is no more than a mild refinement of Lindemann's.

PARE is an acronym developed by flight instructor Rich Stowell to help pilots remember the sequence of control inputs necessary for a spin recovery: Power (close the throttle), Ailerons (neutralize), Rudder (full deflection in

direction opposite the spin), Elevator (first, stick forward to un-stall the wing). An alternative is the Muller-Beggs method, which is similar to PARE with one dramatic exception: for PARE's "neutralize ailerons" phase of recovery it substitutes "take your hands off the stick." Neither of these methods is guaranteed to work for every airplane in every situation.

I needed to refresh my memory about PARE, so I sought out aerobatics instructor Adam Cope, who flies a Super Decathlon out of tiny Potomac Airfield, just outside of Washington, D.C. Cope is a born teacher. He may look young, but he knows his aerodynamics and excels at clear and sensible presentation. We first review the basics with his dog-eared charts. Figure 1 illustrates the most basic principle: As long as air flows smoothly over the wing, the wing will produce lift. As the wing's angle of attack increases, air flowing over the top of the wing begins to detach from the wing, and with each increase in the angle of attack, the point of detachment moves closer to the wing's leading edge. At some stage, which is different for each airplane, lift will no longer be sufficient to sustain the weight of the aircraft: That configuration of the wing with respect to the relative wind is called the critical angle of attack. Figure 2 demonstrates that a wing moving through the air produces both lift and drag. As the angle of attack increases, lift and drag both increase proportionately. At the critical angle of attack, however, lift drops dramatically while drag continues to increase. The result is a stall. A spin occurs when one wing stalls more sharply than the other, generally as a consequence of exceeding the critical angle of attack in connection with yaw (movement around the aircraft's vertical axis).

In the air in his Super Decathlon, Cope has me do a few aerobatic maneuvers to get me used to employing the rudder, which will help control the airplane during spin recovery. Cope has prepared me intellectually, but no ground school can prepare you for the abruptness with which an airplane flips over, nor did I retain a memory of that shock from my training years ago. We do only two turns on the first couple of tries and I am able to recover adequately, but then we graduate to four- and then six-turn spins. As the number of turns mounts, the spins get tighter and faster. At four turns, I'm experiencing nystagmus—the eyes rapidly oscillate from side to side as they attempt to establish a point of reference. Consequently, when Cope tells me to recover, I perform the PARE sequence, but I'm unable to distinguish when the rotation stops, so we nearly fall into a spin in the opposite direction. Though I am too busy to detect it, I suspect that Cope is nudging the stick to keep me from getting into too much trouble. It becomes clear to me that without regular practice, I would not likely survive a spin if I allowed it to develop into more than three or four turns.

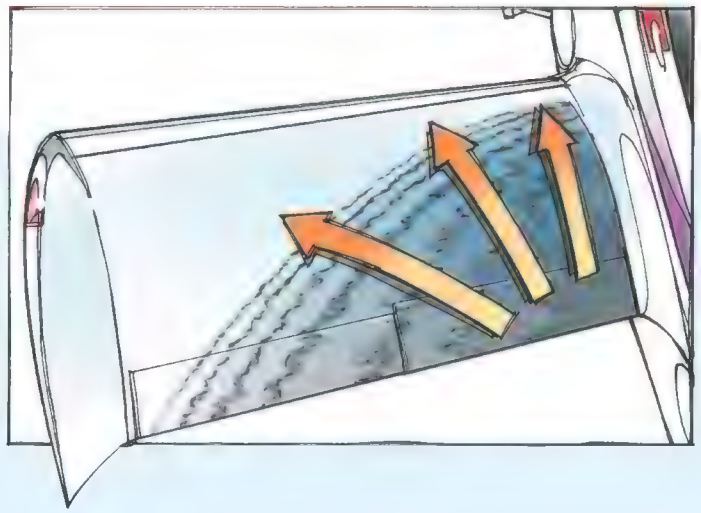
But the debate centers on whether spin training would improve pilots' chances of avoiding inadvertent spins in the first place, and, if a spin should occur, would spin recovery training improve the pilots' chances of survival. To understand that debate, some background is necessary. When the FAA eliminated the requirement for spin training in 1949, it shifted the burden of responsibility to the aircraft manufacturers, to some degree, by stating that airplanes should be made more spin-resistant. But while the FAA wanted more spin resistance, customers demanded airplanes that could perform, and at the time, those were somewhat incompatible goals: Increasing spin resistance necessitated a loss in aircraft performance—generally losses in speed and fuel efficiency.

Whatever spin resistance was built into general aviation aircraft manufactured before the 1990s was largely an accidental byproduct of other design considerations. A few craft were quite spin-resistant, but most were not, and some had unrecoverable spin modes, even after the FAA began requiring manufacturers to demonstrate

NASA LANGLEY RESEARCH CENTER

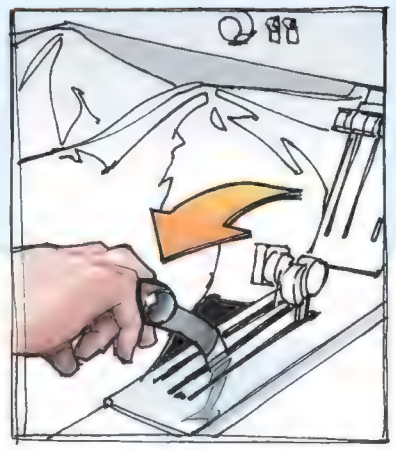
Surviving a Spin

STALL PROGRESSION ACROSS WING



When airflow over the wings slows to the point that the wings no longer generate lift, the flow separates and the airplane stalls. Wings are designed so that the stall, or airflow separation, begins on the inboard section of the wings, allowing the pilot to retain roll control with the ailerons, outboard surfaces that remain effective.

POWER TO IDLE



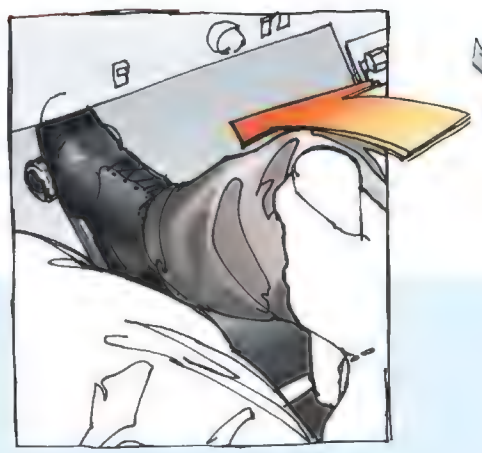
If the pilot flies into a deep stall, the airplane may enter a spin, which begins with the airplane's nose dropping toward the ground and one wing flipping over the top. The first step toward spin recovery is to close the throttle so that the engine is at idle power.

NEUTRALIZE CONTROL STICK

The second step of spin recovery is to move the control stick to its center, or neutral, position so that the elevators—horizontal control surfaces on the tail—and ailerons are centered.

OPPOSITE RUDDER

After the pilot determines the rotational direction of the spin, he must move the rudder—a vertical control surface on the tail—fully in the opposite direction. For example, if the airplane is in a left-rotating spin, the pilot must press the right rudder pedal, deflecting the rudder to the right. Deflection of the rudder should slow the airplane's rotation.



With the airplane coming out of its spin, the pilot needs to regain controlled flight by getting air to once again flow over the wings. By pushing the control stick forward, the pilot moves the elevator downward, restoring airflow over the wings.

STICK FORWARD

STICK BACK, PULL OUT

With airflow reattached to the wings, they once again generate lift. To return to level flight, the pilot eases back on the control stick, deflecting the elevator upward and raising the nose.

HARRY WHITVER

With rudder deflected to the left, flight instructor Rich Stowell deliberately enters a left-rotating spin in his aerobatic Decathlon.

that their craft could recover from a one-turn spin. Additionally, we now know (though it was not common knowledge until the late 1980s) that anything you do to improve spin resistance has the unfortunate side effect of increasing the difficulty of recovering from a spin. Unless you could produce a spin-*proof* aircraft, the trade-off was a risky one.

So while the general trend over the years was for aircraft to be somewhat more spin-resistant because engineers were learning to design better airplanes, the high accident rate from stall/spin accidents clearly demonstrated that aircraft built before the 1990s did not meet the FAA's goal for spin resistance.

At this point, it must be said that nearly everyone is in favor of spin training, even the FAA, as long as it's not required. Says the FAA's Wensel: "The FAA doesn't prohibit spin training. That's why we require CFIs [certified flight instructors] to undergo spin training, so they can pass that on to their students if either the instructor or the students wish that training to take place." Warren Morningstar, vice president of communications for the Aircraft Owners and Pilots Association, says his organization agrees with the FAA's position.

When the online publication AvWeb (*www.avweb.com*) informally surveyed its readers two years ago, however, it found that of 1,186 responding to the question of whether spin training should be required for a private pilot's license, 57 percent said yes and another 36 percent said it should be encouraged but not required. Only seven percent of respondents said spin training should not be required.

Aerobatic pilot Tom Alison, a retired U.S. Air Force SR-71 pilot and head of the National Air and Space Museum's artifact restoration division, is an advocate of spin training for private pilots. "I believe that a pilot should understand and not fear the spin," he says. Alison, who has witnessed even experienced pilots employ incorrect methods to get out of a spin, says: "Exposure to the spin maneuver and experience in all its aspects—entry, recognition of various spin modes, and appropriate recovery procedures—is the only way a pilot can really master this aspect of aviation."

"A spin is a very dangerous situation to find oneself in," says private pilot Bob Curran, who flies a Bellanca Citabria. "To the untrained pilot, what may seem the logical method of exiting a spin will instead result in perpetuating the condition, perhaps making it worse. There are few things in flying that can result in a more rapid loss of altitude or overwhelm the thought process of an unskilled pilot than entry into an inadvertent spin."

When Curran went through spin training, his flight instructor had thoroughly briefed him on what to expect and had rehearsed the recovery procedure with him. Still, Curran's first spin was a "shocking experience even though it was fully intentional," he says. "To this day, I still practice spin recovery on a regular basis."

In 1976, the FAA published the results of a study (FAA-RD-77-26: "General Aviation Pilot Stall Awareness Training Study") that were the justification for its policy that teaching people to avoid spins in the first place is a better means of saving lives than teaching people to get out of them. That policy was further refined in 1991 (Advisory Circular 61-67B) and in 2000 (61-67C), but not fundamentally changed. Statistics seem to support the FAA's judgment. The 1976 report states: "More fatal and serious injuries have occurred from stall/spin accidents involving general aviation aircraft than from any other single type of accident."

In 1980, U.S. Congressman Jim Lloyd of California held three days of hear-

OPPOSITE: BREEZEWAY

ings before the House committee on science and technology, subcommittee on investigations and oversight. The topic was whether spin recovery training should be a requirement for a private pilot's license. The FAA representative at the hearings, Bernard A. Geier, restated his agency's case for teaching pilots spin avoidance, and emphasized the importance of altitude data. "As a matter of fact," he testified, "analysis of stall/spin accident data indicates that only seven percent of stall/spin accidents occur at altitudes where a spin-proficient pilot could effect complete recovery." William Stanberry, senior vice president of the Aircraft Owners and Pilots Association, agreed with the FAA, as did J. Lynn Helms, chairman of Piper Aircraft Corporation and chairman of the General Aviation Manufacturers Association. The hearing's other 13 witnesses all testified in favor of spin training, including Elwood Driver, vice chairman of the National Transportation Safety Board; Verne Jobst, director of both the International Aerobatic Club and the Experimental Aircraft Association; James M. Patton, chief of flight operations at NASA's Langley Research Center in Virginia; and former X-15 test pilot Scott Crossfield, serving as a technical consultant for the House. The committee recommended that spin training be required. The FAA refused.

As a result of those hearings, retired test pilot Tony LeVier, with Crossfield's help, started S.A.F.E. (Safe Action in Flight Emergencies), a program to promote spin and emergency maneuvers training. Today Crossfield recalls: "Tony and [former U.S. senator and military pilot] Barry Goldwater and I, and Sammy Mason and Bob Finch started an organization called S.A.F.E. We gave scholarships from donations given by other aviators." Mason did the flight instruction while LeVier and Crossfield raised the money.

Rich Stowell and CP Aviation restructured Mason's program into their emergency maneuvers training program, giving instruction out of Santa Paula Airport in California, where, over the years, Mason had taught about 800 S.A.F.E. students. Stowell was the first person that the National Association of Flight Instructors ever designated a Master Certified Flight Instructor—Aerobatic, and in his career he has performed more than 23,000 spins. He is a firm believer in the benefits of spin recovery training. However, he warns that student pilots shouldn't overestimate the training that CFIs normally get: two or three entries in each direction. Not enough for proficiency, he says.

In an article published in the May 2002 issue of *Aviation Safety*, Pat Veillette wrote: "Almost one fifth of the spin accidents [in Veillette's 2002 study] involved a flight instructor. More than a decade ago, I did a study of stall/spin accidents that was published by the National Research Council. Among its findings were the lack of standardization and quality control of flight instructor candidate preparation, particularly in regard to stall/spin knowledge and preparation."

Veillette's study also shows that many of the stall/spin accidents in his sample were due to errors by highly experienced fliers. Of the pilots involved in accidents, 13 percent were certified aerobatic competition pilots, 27 percent had previous spin training, and nearly a fifth were CFIs. Clearly, extensive experience far from guarantees success in the confusion of an unexpected spin, but a significant number of spin accidents still befall less experienced pilots.

When are spins likely to occur? Many happen around airports—when aircraft are accelerating or slowing. On February 14, 1997, a pilot carrying four passengers in a single-engine Piper PA-24-250 Comanche took off from the airport in Farmington, New Mexico, at night. During the initial climb, observers saw the Piper stall, enter a spin, and hit the ground in a nose-down attitude; all aboard were killed. And on May 31, 2000, a recently certificated flight instructor and his passenger/student were turning to final approach at Palm Springs, California, in a Cessna 152. The air traffic control tower requested that the Cessna make a series of S-turns to maintain proper spacing between it and an aircraft waiting to start its takeoff roll. Witnesses observed the Cessna's wings rock right and left before the craft stalled and spun to the ground from 250 feet; both pilot and student were killed. The NTSB determined probable cause to be the failure of the pilot/flight instructor to maintain sufficient airspeed.

Some pilots disagree with the FAA's contention that the altitudes typical of takeoff and landing are too low to allow for spin recoveries. Says Scott Crossfield: "When I was an instructor in the Navy, I had a student in an SNV who put me on my back on final approach. I was half asleep back there, but because I'd had good spin training, I managed to roll that thing all the way around just before it landed and didn't even hurt it." Though few of us can aspire to Crossfield's skill, many of us believe that a properly spin-trained pilot could recognize the problem quickly enough to recover in a quarter-turn or half-turn, perhaps making the difference between death and survival. Says Crossfield: "It should become almost instinctive that you pump in rudder against the spin, and most of the time that will catch that wing."

Verne Jobst is still a director at the Experimental Aircraft Association and was inducted into the Flight Instructors Hall of Fame in 1999. He is also a pilot examiner. He has not changed his mind a bit since he testified before Congress in 1980. Jobst believes that many certified flight instructors are not qualified to teach spins. "Instructors mostly get their three entries to the left and three en-

In 1949 the FAA eliminated the requirement for spin training. "We saw that 48 percent of the fatal accidents from that era involved stall/spin, and of those the majority were training-related," says the FAA's John Wensel. "We were killing people in trying to eliminate the very thing that was happening to them."

tries to the right, and that's it," he says. "There are many instructors who—though I doubt they would admit it—don't even get the minimum required. Their instructors just sign them off." Jobst says that in his career as an examiner, he has encountered several.

Jobst tells a story about one of his students: "He was sort of manhandling the airplane and slowing it up and slowing it up. And sure enough it let go. He threw his right hand up past my head. Luckily I ducked or I wouldn't be here talking to you today. His hand flung out and he yelled, 'You got it!' So when I recovered he said, 'What was that?' I said, 'It's a spin.' That convinced him to get spin training. Had he been alone with that first spin, he would likely be dead."

Jim Patton is unequivocal, as he was in his 1980 testimony. "Certainly pilots should know how to recover from a spin," he says. "Like buying an insurance policy. If the first time you go into a spin is inadvertent, especially if you're at pattern altitude, then it's too damned bad because you're not going to do the right thing. The problem is that instructors are given only a once-in-a-lifetime exposure to spins. They should have to remain current in spin recovery." Patton has a unique perspective on spins: He was chief pilot for a stall/spin research program conducted at NASA's Langley Research Center from 1977 to 1987. Before that he had been an FAA test pilot, testing, among others, two aircraft known to have unrecoverable spin modes. The original intent of the FAA study was to examine the aerodynamics of a spin. By the time the study ended, Patton and his investigators had progressed to developing efficient methods of building spin resistance into general aviation aircraft.

NASA LANGLEY RESEARCH CENTER

A NASA technician awaits permission to drop a radio-controlled model of an X-31; as it plummets, a ground crew will monitor its behavior in a spin.

For the NASA experiments his group acquired four general aviation aircraft that they modified radically to examine how changes to the standard airframe would affect spin characteristics. "The goal was to determine what was happening with spins, at least at first," Patton says. His test flights with various aircraft modifications soon indicated that very small changes to the wing would produce huge differences in performance. "With simple changes to the wing we could change an airplane that flew like a kiddie car into a tiger that would eat you up," he recalls. Thus came the realization that, with slight modifications, an airplane could be produced that was even more resistant to spins. The experimenters could say: "Hey, this is a very safe airplane. Not spin-proof, but it gives plenty of warning, lots of buffet, very little roll-off laterally—a long period of telling the pilot 'Hey, you're doing something wrong.' " In fact, a new generation of aircraft, particularly Lancair and Cirrus, use wing leading edge cuffs that were pioneered in Patton's program. The cuffs, which improve the stall characteristics of an aircraft with only a negligible reduction in its performance, increase the radius of the wing's leading edge and are attached so that there is a disruptive edge between the cuff and the wing itself. The effect of the cuff is to keep a stall from progressing from the inboard section of the wing to the outboard section.

No ground school can prepare you for the abruptness with which an airplane flips over.

Both the General Aviation Manufacturers Association and the FAA also believe in the importance of increasing the spin resistance of aircraft. In fact, the FAA argues that newer airplanes are less spin-prone, so there is less need for spin training. For that reason, Russell Lee, a private pilot and aeronautics curator at the National Air and Space Museum, thinks that obtaining a private pilot's license should not require spin recovery training. He feels that many modern training-level and entry-level aircraft behave so well when operated according to the flight handbook that spin training to fly these airplanes is not necessary. "I think that in the vast majority of mainstream aircraft to which private pilots have access, there are simply too many clues designed into the aircraft to tell the pilot that he is headed for a spin," says Lee. "Decaying airspeed is signalled not only by several instruments, but by a drop in wind noise and a drop in control pressures. Then there is pitch attitude change and stall warning—and all this happens before the airplane actually stalls. Most [modern training aircraft] types must then be held in the stall for some seconds to even fall off on a wing. To enter a genuine, full-rotation spin requires, in my experience with entry-level aircraft, aggressive use of pro-spin control movements such that the pilot has to purposely force the aircraft to spin."

Lee has himself gone through spin training, and he says that it has made him a "better pilot, more prepared for unusual attitudes due to turbulence." Though he doesn't think spin training is necessary for beginning pilots, he does believe that once pilots graduate from entry-level aircraft to high-performance ones, they should get full spin training, or else they are putting themselves and those around them at risk.

Though new aircraft designs improve spin resistance, there are pilots still flying thousands of aircraft with less spin resistance, and some of them are going to find themselves in deadly spins. The real question is whether any of these lives might be saved by spin entry and recovery training. The FAA's 1976 study sends a mixed message, so perhaps it's time for a new study with a larger, more statistically valid sample. In the meantime, I'll go spin every now and then, learn all I can, and try to avoid being the one who makes that fatal mistake.

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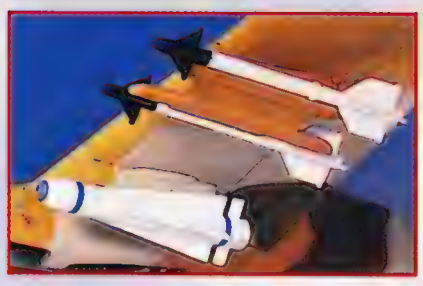

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BACKGROUNDER

by Tony Reichhardt

State of the Station

After almost 20 years of design, redesign, re-redesign, and, finally, construction, the International Space Station is very nearly finished. Tentative applause. Now the bad news:

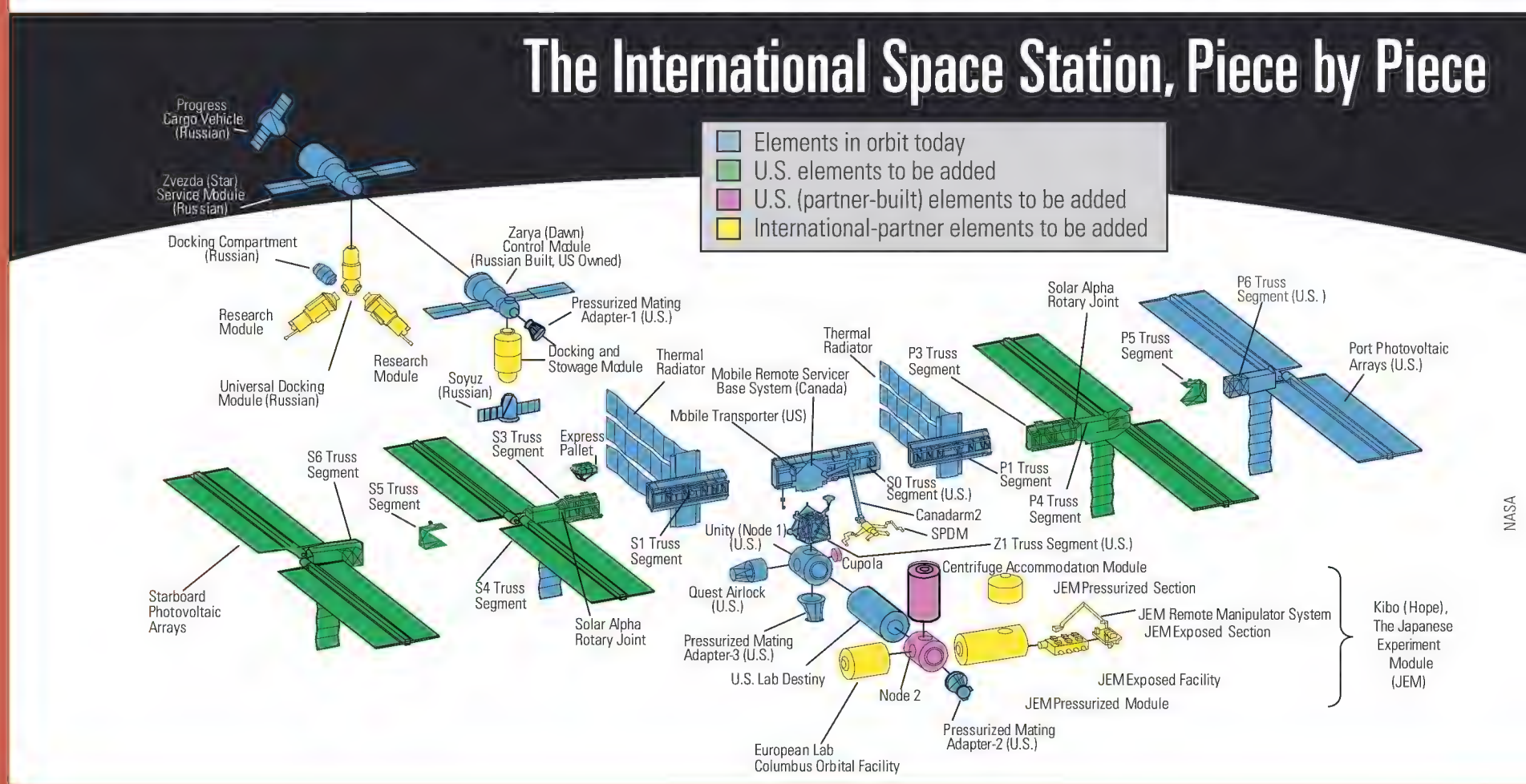
For all the time and money ($24.4 billion and counting) spent so far, the station will have little use as a research laboratory until a full crew arrives to conduct experiments and serve as test subjects—or so says just about every scientific advisory group NASA has asked for an opinion.

Just what constitutes a "full" crew has been a matter of debate. A task force led by astronaut-turned-chief-NASA-scientist Shannon Lucid recently concluded that a full research load will require 5.6 astronauts. When those 5.6—call it six—people will move in is far less certain. First they'll need lifeboats that can evacuate all six in an emergency. (The Russian Soyuz, the station's current lifeboat, holds only three.) That means NASA has to design, build, and fly a brand-new vehicle—the Orbital Space Plane—something it hasn't done in 30 years.

Despite this enormous hurdle, station managers had to be feeling pretty good going into 2003. Sixteen of 23 assembly flights, and more than 50 spacewalks, had come off with barely a hitch, and no one could deny the project's astonishing success in purely engineering terms. Astronauts had delivered 200 tons of hardware to orbit, and most of the rest was built and awaiting launch at the Kennedy Space Center in Florida. Even the program's chaotic finances were finally being whipped into shape.

Then: *Columbia*. Today a skeleton crew of two astronauts is marking time on the station, performing essential maintenance instead of running the busy program of scientific research they had trained for. About the only noteworthy thing that's happened onboard since the shuttle accident—other than the July celebration of the 1,000th day of astronaut occupancy—was the August 10 video-link wedding of cosmonaut Yuri Malenchenko with his Earthbound bride. A space first, but hardly what NASA had been wishing for.

At least the station is in no imminent danger of falling from orbit or being shut down. The international partners,



including Russia, whose Soyuz is the only vehicle currently ready to reach the outpost, agreed after the accident to take whatever steps are necessary to keep the station supplied and operating until the shuttles return.

When that will be is anyone's guess—NASA hopes next summer. Station managers also desperately hope to pick up where they left off, and to stick with the pre-*Columbia* order of assembly flights. That plan could unravel if the three shuttles left fly less frequently as a result of recommendations by the *Columbia* accident investigation board. But assuming the schedule holds, here's how things will go:

The next assembly flight will carry up research "racks" and other equipment to outfit the inside of the station's laboratory module, *Destiny*. Then for the next five flights the action shifts outside: Astronauts will add sections to the station's 356-foot backbone, or truss structure, and unfurl giant solar arrays to increase electrical power on the station. When finished, the backbone will support almost an acre of solar panels, generating 100,000 kilowatts. The Tinkertoy-style assembly job is hardly Tinkertoy-easy, however. Multiple spacewalks will be required to connect electrical and fluid lines, and the segments need to be positioned delicately, with clearances often measured in inches.

The last of these assembly flights will be the most challenging, as astronauts, with the help of the shuttle's robot arm and a larger one on the station, detach one of the giant truss/array segments—labeled P6 for port side 6—that has supplied power since 2000. Originally positioned at the center of the station for balance, it will now be moved to its final resting spot: the end of the backbone. NASA engineers don't relish the idea of scrolling up the arrays and then unfurling them again, especially since the original unfurling didn't go smoothly. But it has to be done.

That mission will be followed by an assembly flight to attach the U.S.-built Node 2 module, which connects the modules that will be provided by Europe and Japan. By mid-2005 then (in the unlikely event that the pre-accident timetable holds), the U.S. part of the station will be finished. Sort of.

In early 2001, when George W. Bush came to Washington, his staff—including newly appointed deputy budget chief Sean O'Keefe—was appalled to learn that station managers had just discovered another $5 billion overrun. The White House took NASA to the woodshed and said the agency couldn't go beyond "core complete"—meaning the Node 2 module—until it got its fiscal house in order. The United States will still honor its commitment to its international partners to launch and attach the Kibo (Japanese) and Columbus (European) laboratory modules, as well as any research modules cash-strapped Russia can afford. But moving beyond a three-person crew will require White House approval.

Before the *Columbia* accident, station managers had largely fixed their technical and budgetary problems and were on the verge of getting that go-ahead. An earlier plan to build a habitation module for the crew had been scrapped. Instead, NASA began studying ways to provide air, water, and other supplies for six or more people in the existing modules.

That makes the Orbital Space Plane the wild card in the space station's future. O'Keefe, who—in either a clever career move or an example of karma—now heads NASA, has asked industry to accelerate designs for such a vehicle. Originally the space plane was supposed to be ready by 2010. Now NASA wants it to start flying by 2008 or sooner—a tall order.

But until it does, the space station will not be able to live up to its potential as a research laboratory, and critics will continue to express doubts about its value. Which leaves the orbiting outpost stuck again, even as the finish line finally appeared within reach.

IN BRIEF: What's Done and What's Left to Do


NASA

- The station has about the same room as a three-bedroom house. As of September, 20 people had lived there—10 Russians and 10 Americans.
- NASA still needs seven assembly flights to achieve "U.S. core complete," a station that will house three astronauts and provide an attachment point for other nations' modules.
- The European Space Agency's Columbus module, Japan's Kibo module, and a Japanese-built, U.S.-financed centrifuge for conducting biological research at various levels of gravity will be attached within three years of "core complete." Kibo has an outside "porch" for experiments that require exposure to space.


Space Station's Future Grows More Uncertain

By William Booth

An unmanned Russian resupply craft lifted off yesterday from the Baikonur Cosmodrome in Kazakh-... carrying mail, food, propel-... and scientific equipment to ... the multibillion-dollar, 16-nation ... for construction ... NASA did not improve.

The platform's cost, supported by 16 nations, could exceed $96 billion. In the last two years, Congress ... for construction ... sold to the public, in part as a platform to produce world-class sci... However, with a crew of ... do much with a three-person crew," he said.

NASA Urged To Reconsider ISS Cuts

Japan, Europe Say U.S. Should Fulfill Its Obligations

Uncertain

THE NEW YORK TIMES NATIONAL SATURDAY, NOVEMBER 3, 2001 A9

Management of Space Station Is Criticized

By WARREN E. LEARY

WASHINGTON, Nov. 2 — The International Space Station program ... mated earlier this year that these costs would be exceeded by $4 billion, to $5 billion. The White House told NASA it would have to absorb the ... The committee suggested several ways for the agency to reduce costs, including reducing the number of space shuttle flights to the station to ... enance and ... McElroy, a

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Future Grows More Uncer

Flights Likely to Resume, but NASA Itself May Enter New Or

By Eric Pianin

Washington Post Staff Writer

... as wasteful. Some lawmakers disenchanted with the shuttle and international space sta... NASA hasn't really presented better alternatives, or that the Bush administration would ... gress time to digest the findings ... hold hear... ings in the fall and rewrite NASA's ...

THE CONT

IN THE FIGHT FOR THE GLOBAL AIRLINE MARKET, AIRBUS WAS DOWN FOR THE COUNT. BUT NOW IT'S LEADING ON POINTS.

EN DIER

BY BILL SWEETMAN

In Toulouse, it's a point of local pride that a stone flung from the city's walls splattered the brains of the northerner Simon de Montfort during the Albigensian Crusade in 1218. Located about 350 miles south of Paris, rural Toulouse is also distant in both history and sensibility from France's capital city. So to describe an Airbus product as a "French aeroplane," as British airline buccaneer Sir Freddie Laker once did, is to miss an important cultural point.

The region's character is still apparent a few hundred yards from the headquarters of Airbus, where we pass a small farm with a few tank-size Charolais cows. Our destination is a double row of airplane hangars, each big enough for two soccer fields. Next year, workers will begin to assemble the world's largest jetliner—the 550-seat, 560-ton, $275 million Airbus A380.

Today Airbus is thriving, but success was never a certainty. In 1974, Boeing vice president Jim Austin described the first Airbus product as "a typical government airplane. They'll build a dozen or so and then go out of business." Austin spoke from experience, and he was almost right.

Europe had invented the jet engine, built the first jet and turboprop airliners, and was building Concorde. But Boeing and Douglas were doing to the Europeans what de Montfort had done to the Cathar heretics. The 116 options to buy Concorde had melted away. Dassault had produced the Mercure, a Boeing 737 lookalike, but was never going to sell more than the 10 copies it had foisted on France-owned Air Inter. West Germany's first and only commercial jet, the VFW-Fokker 614, was a dog. Britain was delivering a few last BAC One-Eleven twinjets and Hawker Siddeley Tridents—like smallish 727s—to Romania and China. Thanks to some crafty, almost underhanded maneuvering led by a French engineer named Roger Beteille, Toulouse had one rock left: the Airbus A300B.

Beteille was surprised when, in 1967, he was asked by his bosses at Sud-Aviation to form a team to design a jetliner. For 10 years he had headed a team in Cannes developing France's nuclear missiles and its first satellites. Before that, he had been in charge of flight-testing the Caravelle, a rear-engine twinjet that had sold well in the late 1950s. United Airlines bought Caravelles, and the French almost had a deal with Douglas to build them, but the French balked at the upfront cost, and Douglas went on to build DC-9s.

Europe's mistakes taught Beteille some key lessons. "You cannot com-

LEFT: AIRBUS; OPPOSITE: MARK WAGNER/AVIATION-IMAGES.COM

The A340-600 (left) is a recent hit from Toulouse, France (above).

pete with somebody by doing what he's doing—you have to do something better, or at least different," he says. In the mid-1960s, with Boeing already building the four-engine 747 and McDonnell Douglas and Lockheed discussing three-engine wide-bodies with U.S. airlines, the field was open for Europe to build a big twinjet.

Europe's national aircraft industries were starting to work together, but jealousies prevailed. The Germans had money, but the British and French treated them as metal benders, not partners. The French government, embroiled in the summer street riots of 1968, had a record of seeking leadership in projects, then threatening to go it alone if their demands were not met. In Britain, many politicians and civil servants thought engines were a better business than aircraft. Working alone, none of them had competed successfully with the Americans, so Beteille's mission to assemble a multi-nation team made sense. But it would be immensely complicated.

By late 1967 the outline of an airplane with two big Rolls-Royce engines was taking shape. The name "Airbus" came from the Germans. The number "300" matched the vehicle's 300-seat capacity. But Beteille was worried that with each design iteration the airplane was getting closer in size to the rival three-engine U.S. aircraft. And in the course of visits to Rolls-Royce's fusty headquarters in Derby, he had noticed something even more disquieting.

Most of the British government's share of the A300 investment money was to go to Rolls-Royce for the RB.207 engine—a paper study at the time. But the company was also trying to sell the smaller RB.211 to Lockheed for its TriStar. Beteille discovered that "the people that I used to discuss the RB.207 with had disappeared. It wasn't hard to figure out what was going on. Rolls was betting everything on the smaller engine, and they were using the U.K. government's money for the RB.207 on the RB.211."

In March 1968 Rolls-Royce won the TriStar business. Beteille was not sure the British government would pay for both engines or that Rolls could develop them even if it got the money. "I was convinced that the venture was dead," Beteille recalls. The only option was to restart the design, "to do something smaller, either with an existing engine or an engine that was being developed for somebody else. But if I had told the partners that, they would have said 'It's dead. Let's stop it.' "

Instead, Beteille gathered 10 engineers and handed them a specification for a twin-engine, wide-cabin jet, written in 1966 by Frank Kolk, chief engineer at American Airlines. Beteille told the team to follow the specification and use existing engines. They came back with a 250-seat airplane that had eight seats abreast rather than nine but could carry the same freight containers as the bigger American aircraft. "We kept the designation A300—it was one way of not drawing attention to what we were doing," says Beteille. At the end of 1968 the Airbus team announced that they had downsized the new airplane and eliminated the RB.207. The British government walked out, but the British firm Hawker Siddeley remained as a subcontractor, and the German and French governments agreed to split the costs. Meanwhile, Beteille had met Felix Kracht, who was to become another father of the Airbus organization. Kracht, a sailplane pioneer, had experience in international programs from the Franco-German Transall C160 military transport.

By the end of the 1960s, the center of gravity for the Airbus program was located in France, at least in part because the French had assigned important talent and more people to the project. Under president Henri Ziegler were Beteille as technical director and Kracht as production director, and it was the latter two who defined the program as it exists today.

Kracht, who died last year,was instrumental in establishing the technique of assembling large components, fabricated in different countries, at a single location. One of the most expensive mistakes on Concorde had been the use of two final-assembly lines

Felix Kracht, Roger Beteille, and Henri Ziegler (left to right) crewed an early A300B mockup.

Current Airbus CEO Noël Forgeard greeted reporters at the recent Paris Air Show with a confidence born of owning half the airliner market.

Well-dressed Bernard Lathiere (left) and Jean Pierson (right) fete the A310's 1982 first flight.

Kracht devised the solution for final assembly: Subassemblies meet in Toulouse (here, an A340 is born).

LEFT:AIRBUS; CENTER:MARK WAGNER/AVIATION-IMAGES.COM; RIGHT:AIRBUS; OPPOSITE:MARK WAGNER/AVIATION-IMAGES.COM

in Britain and France doing exactly the same thing—with an enormous duplication in tooling and overhead.

"No way," recalls Beteille. "One line was a prerequisite." That line would be in Toulouse—and not for French *gloire*, Beteille maintains. "It's the only place in Europe with enough airspace to do flight tests," he says. But he adds that if they'd done everything on an assembly line, hundreds of workers would have had to be transplanted from Hamburg and Manchester to Toulouse. Kracht and Beteille thought the workers would be more productive at home.

The solution was called "light assembly": The body and wing sections would be completed in Germany and Britain, with wiring, fluid lines, air ducts, and insulation in place, so fewer people would be needed in Toulouse for final assembly. And that is how every Airbus is built today. Management was organized according to the same principle: Look at Concorde and do the opposite.

The Airbus partners agreed to delegate all day-to-day decisions to a small headquarters in Toulouse. It would do basic design, assembly, flight test, sales and marketing, and support for the new airplane. It would report to a supervisory board, but would make all decisions autonomously.

In July 1973, Adam Brown, now Airbus' head of strategic planning, joined the firm directly from Hawker Siddeley's Hatfield factory, where he had helped sell Tridents. "It wasn't a very difficult decision, although a lot of people thought we were crazy," Brown recalls. "But what was there to lose?"

"We Germans thought we were coming to a French company, but it was the French who were totally lost," says Jurgen Thomas, now special advisor to Airbus' CEO, Noël Forgeard. "The French were hierarchical, with no delegation of power. They weren't in a position to take a decision in a meeting." The British and Germans resorted to subterfuge, Thomas recalls. "We let things leak ahead of the meeting, so that the French could propose it as their solution. It was much easier."

Thomas admits that some stereotypes of German management proved true: "There was still a Prussian disease. It was formal, the agenda had a time slot for each item, and there were separate paragraphs for everything." The British encountered a different culture at the Airbus facility. At de Havilland's Hatfield division there were six levels of company dining. "They had toilets for different levels of staff," recalls Thomas. Airbus people took lunch in an all-ranks café. "You'd see a vice president having lunch with a secretary," says Thomas. One senior executive from Hawker Siddeley stomped out in disgust.

"Only the French would have done it" is how Adam Brown recalls the first A300 sales tour, a six-week odyssey around the Americas from Rio to Chicago in 1973. French fashion designer Andre Courreges designed the women's cabin crew uniforms. Ted Lapidus dressed the men. Four and a half tons of Moet & Chandon champagne occupied the cargo hold. They got away with such frills because nobody cared. "The Airbus people were looked down on by people on Concorde," Thomas says. Even the Mercure got more attention in Paris, thanks to Dassault's political pull.

The team was determined to be on time and within budget—a first for any European joint program. "The motivation was incredible," says Thomas. "When I called people to work on Saturday or Sunday, it was the people who weren't called who were insulted." The A300 debuted on schedule in 1974.

With soaring fuel prices, it was the worst time for a new airplane. Airbus logged a dribble of orders in 1975, followed by a 16-month drought. From the end of 1975 until April 1977, not one aircraft was sold, and "white tails"—airplanes without customers—began to appear on the Toulouse ramp.

In the dark days of 1976, Thomas recalls, "we had a meeting of 25 or 30 people, with this gentleman I had never seen before." Bernard Lathiere was a graduate of the Ecole Nationale d'Administration, where France trains its elite, and he had been sent on a mission: Step in as president, replacing Ziegler, and either kill Airbus or save it. A sharp contrast to his immediate subordinates, the lean, ascetic Beteille and Kracht, Lathiere was a florid gladhander, a natural speaker who became Airbus' chief salesman.

One light gleamed: Western Airlines had ordered eight airplanes, with an

Britain's Trident looked the part of a 727 but couldn't compete.

Dassault's Mercure, designed for domestic routes in France, was too limited in range for U.S. airlines, and only 10 were ever sold, all of them to the short-haul line Air Inter.

Denmark's Cimber Air was sole buyer for the VFW-Fokker 614.

LEFT AND CENTER: MARK WAGNER/AVIATION-IMAGES.COM; RIGHT: AUSTIN BROWN/AVIATION-IMAGES.COM

option for four more. It was the first time a U.S. airline had bought a European jet since 1964. But at the end of January 1977, Western announced it had ordered 727s instead. Airbus canceled orders for long-lead items—parts that would be needed for aircraft delivered in 1979. It was close to the end.

Then, in April, Thai International ordered four airplanes. And Eastern Airlines, losing money and desperate for modern aircraft, agreed to accept four A300s on a no-charge, six-month lease. If Eastern found the A300 as cheap to buy, operate, and maintain as advertised, it would buy 28 airplanes on very favorable terms for the airline. In April 1978, Eastern signed up to buy 23 A300s.

Before the Eastern sale, Airbus had kept one major plan under wraps. From the start, Beteille had insisted that the Airbus be developed into a family of aircraft; he did not want to produce a dead end like the Caravelle. "I had to keep that secret," he recalls. "Everyone would have said I was crazy." Adam Brown first saw such a proposal in September 1975. There was a 200-seat aircraft, the A300B10, for post-1973-fuel-shock markets; a stretched A300B9; and a long-range, four-engine A300B11.

Beteille based his family plans on a simple formula. In the 1970s, he points out, Boeing had about 60 percent of the market and McDonnell Douglas had 30 percent. "Boeing was making money, and Douglas was just about covering its costs. So either Airbus gains 30 percent of the market, or we never cover our costs, and one day or another, we die." Until the sales drought broke, Airbus did not even want to talk about the 200-seat B10. With growing sales, it took the plan public in 1977.

But there was one problem: Boeing was developing two new airplanes—the narrow-body 757 and the twin-aisle 767—and looking for partners. In Britain, the government wanted work for the nationalized British Aerospace, which had absorbed BAC and Hawker Siddeley. Boeing offered a package deal: British Aerospace would build the wing of the new 757. It would have a Rolls-Royce engine, with British Airways and Eastern Airlines as launch customers. Rolls-Royce was 100 percent behind this option, as was British Airways.

MARK WAGNER/AVIATION-IMAGES.COM

When subassemblies of this A330 arrived in Toulouse for assembly, all the wiring, ductwork, and insulation were already in place; the interior's next.

But France and Germany no longer wanted British Aerospace (the former Hawker Siddeley part) as a subcontractor to Airbus. Either BAe would come on board as a full government-backed partner, or Germany would build the wings of the A310, as the B10 was now known. The clock was ticking: In July 1978, with an order from United, Boeing launched the 767, calling it "the A300 replacement." In a final compromise, Rolls-Royce got money to build the 757's engine, British Airways bought the Boeing airplane that it wanted, and BAe joined Airbus as a full partner.

European consortia like those for

Transall, a French-German military transport, and Concorde had been one-product deals. With the A310, Airbus changed: No longer the group that made the A300, it became Europe's airliner builder. Before the A310, Aerospatiale, BAC, and others had proposed a smaller European jet to compete with the 737 and DC-9. Afterward, there was little argument that this smaller jet would be an Airbus product. But Beteille saw a problem with the new project: "I was convinced that the 737 was so good that there was no way to compete with it by doing the same thing."

The former rocket engineer—"I was used to missiles, where everything was automated"—made what Adam Brown calls "a very gutsy decision": The A320 would have fly-by-wire (FBW) flight controls. In the A300, the yoke and rudder pedals were connected by cables to the hydraulic actuators that moved the ailerons, rudder, and elevators. On the A320, the controls would issue commands to computers, which would send electronic signals to the actuators. Concorde had an analog FBW system, and the technology had been used on fighters, but this would be its first use on a mass-produced commercial airplane.

The first of Beteille's family: The 200-seat A300-B10 became the A310.

MARK WAGNER/AVIATION-IMAGES.COM

On conventional jets, springs and dampers give the yoke and pedals artificial feel. The pilot has to push harder on the controls to make the airplane climb or turn, the resisting force warning the pilot that the airplane is approaching its limits. The A320, instead, had envelope protection: The airplane wouldn't stall, overspeed, roll inverted, or do anything the computers would not permit. Since the force needed to move the yoke was no longer necessary, Airbus eliminated both the force and the yokes, which were replaced by video-game-like sticks on the left and right sides of the cockpit.

Fly-by-wire made the A320 clearly different from the 737, and savings in weight and maintenance offset the development cost. Northwest Airlines ordered 100 A320s in 1986, and United Airlines would eventually order almost 200 airplanes. It was Airbus' first full-scale break into the U.S. market.

The A320 had been in service only a few weeks when, in June 1988, an Air France A320 crashed into trees at the French town of Mulhouse. The pilots, who survived, claimed that they had tried to push the aircraft to perform a go-around but that the engines did not respond. Two similar accidents followed.

The root cause, it turned out, was that the A320 was very easy to fly, and the ease masked the complexity of its automated controls. In its early A320 pilot training courses, Northwest experienced failure rates in the double digits. In 1993, Northwest flight operations director Clay Foushee summed up the A320: "On a gusty day at Washington National, you can look at an A320 fly and then watch anything else. Even with the unaided eyeball, you can see the difference in stability. It will do everything for you very well, but if you just sit there and let it fly itself,

something awful will happen." The solution was to train pilots carefully, with an emphasis on how to use the automated systems. There were no more A320 accidents after 1994.

Boeing took a different approach to its own new design, the 777. Although it had FBW, it did not have envelope protection. The yokes and throttles incorporated electric drives that moved them as if they were connected to cables, even though they were not. Airbus was scornful. "Like putting a steering wheel on a horse," scoffed test pilot Bernard Ziegler.

"Roger Beteille is a man of vision," Adam Brown says today. "Thank God that he did what he did, because it's been fundamental to our success." The same flight control system has been used for every Airbus aircraft since the A320; they all respond similarly to the controls, so once pilots have been trained to fly one Airbus, they can fly any member of the Airbus family and the airlines save a bundle on training. Says Brown: "There is nothing on earth that will do that except fly by wire."

When Roger Beteille retired in 1985, Airbus had launched development of the stretched A330 and long-range, four-engine A340—formerly the B9 and B11—and Jean Pierson had replaced Lathiere. Beteille's parting advice to Pierson: "I told him he should set the target market share to 50 percent—to where we could make profits."

By the time the A330 entered service in 1994, Airbus had introduced three new aircraft in six years. Although the A300 and A310 were selling well, there was no way that the partners could cover the development costs without government help, and that brought a simmering transatlantic trade dispute to a boil. Boeing had cried foul in 1978 after the Eastern sale, but Lathiere wasn't interested in a debate. "I think the big bad wolf is screaming," he said at the Farnborough air show that year, "because Little Red Riding Hood has bitten him in the ass."

Between 1978 and 1985, the A300 and A310 sold as well as the 757 and 767, and Boeing became more concerned. In a 1985 presentation to visiting aviation reporters in Seattle, Boeing declared that Airbus would lose $18 billion by the early 1990s. "We've been very patient for the last 10 years," said, on that same occasion, Boeing vice president Thomas Bacher of the prolonged trade dispute, "but now we're getting more impatient. In fact, we're getting very damn mad." Publicly, European leaders pointed out that Boeing had received government support in the past—the company's jetliner business had been founded on the back of Pentagon orders for bombers and tankers—and the company was still allowed to charge research and development work to the Pentagon.

But there wasn't much substance to the defense, because Airbus finances were a riddle wrapped in a mystery inside an enigma. When Airbus was launched, the chosen legal vehicle for the new consortium was a French creation called a *groupement d'intérêt économique*, or GIE. (Before Airbus, the typical GIE was a wine-producing cooperative.) Owned and supported by the partners, the GIE bought airplane parts from the partners and collected money from the customers.

French law regarded the GIE as a private arrangement between businesses, and did not require it to publish accounts. Profits and losses from building subassemblies, along with the costs of supporting the Airbus headquarters, were buried within the accounts of the partner companies.

From the U.S. point of view, just because the subsidies were hard to find didn't mean they weren't there. Beteille and his colleagues were right: There was no way to make money with less than 30 percent of the market. Without subsidies, Airbus would never have reached that point and would eventually have disappeared—which would have been all right by Boeing's Bacher. "Europe builds beautiful trains and systems like that," he said in 1985. "I challenge the concept that everyone has to build everything." If Airbus could not show a profit it should do the right thing and disappear.

By the early 1990s, with the 30 percent goal in sight, the United States

From the mango-tinted Air Jamaica A321s (below) to the veddy British look of Virgin Atlantic's A340 fleet (left), Airbus liveries of virtually every stripe appear around the globe.

LEFT AND RIGHT: AIRBUS; CENTER: JOHN DIBBS/PLANEPICTURE.COM

AIRBUS

Mama "Beluga" (foreground) and kids. The modified A300 can haul 45 tons of parts to assembly sites.

and Europe managed to settle the subsidy question, agreeing that governments could supply no more than a third of the development cost of any new airplane. One postscript to this story is that the British government loaned money to BAe to develop the A320 with no fixed interest rate or repayment schedule, in exchange for a levy on sales of the aircraft. According to Brown, the government has more than recovered its investment.

The late 1990s saw Airbus moving with immense confidence toward two very important developments: the formation of a single Airbus company and the launch of the largest commercial aircraft in history, the A3XX. The two were intimately linked. The GIE arrangement had been acceptable when Airbus was a small fraction of the partners' business, but not so when Airbus sales accounted for half the gross sales of Aerospatiale and DASA, the aerospace group owned by Daimler-Benz. Moreover, BAE Systems, Aerospatiale, and DASA—none of them, on their own, large enough to go nose to nose with the newly merged McDonnell Douglas and Boeing, Lockheed Martin, or Northrop Grumman—were engaged in a complicated courtship with the goal of forming a pan-European company. To do this, it was necessary to re-form Airbus so that its value could be clearly calculated.

If the GIE arrangement was outdated for Airbus' current product line, there was no way that it could handle the A3XX. Both the partners and the governments that would provide a share of the project's launch costs insisted that the formation of a single Airbus company would have to precede the go-ahead for the big airplane.

By the end of 2000, Airbus was a single company and the A3XX, now the A380, was formally under development. The major owner (80 percent) of the new Airbus company, European Aeronautic Defence and Space (EADS), was itself new, formed after France's Aerospatiale and Germany's DASA merged and acquired Spain's CASA. BAE Systems retains a 20 percent share, and a separate division called Airbus UK builds the wings for the Airbus line.

This year, Airbus, for the first time, is set to deliver more airplanes than Boeing. The U.S. company maintains that the A380 will be a flop and that the world market for passenger versions of the aircraft is no more than 320 airplanes over 20 years. But that opinion doesn't appear to be shared by the airlines, who had signed orders for 129 A380s by mid-2003—more than two years before the first airplane will be delivered.

But at Airbus they still worry. "There's always the danger, for us, to be complacent," muses Thomas. The motivation that existed when Airbus was a tiny upstart on the edge of a cliff over which so many predecessors had recently tumbled can't be re-created today. Airbus internally "still tends to work a lot on personalities," says David Bradley, vice president for customer services. "There's a network that operates in addition to the formal hierarchy.... Hopefully, it will never become fully organized." Airbus UK chief Tom Williams calls Airbus "exciting—it maintains the stimulation that comes from having a lot of different cultures working together. It sounds like b.s., but there is a lot of diversity, and people stand up in front of their peers and defend their ideas."

Jurgen Thomas cites former German chancellor Konrad Adenauer's expression "a Europe of mother countries" to explain the philosophy behind Airbus' cultural mix: "Keep the Bavarians in leather trousers and keep the flamenco in Spain."

Nevertheless, Bradley adds: "People here are Airbusiens—you forget if you're French, Spanish, or Malaysian. You can't speak your own language anymore—you use French phrasing and German expressions."

Nobody at Airbus has the word "diversity" in his or her job title, and Thomas notes, "A reporter once asked me what we were doing to ensure integration within the company. I said 'Nothing' and he would not believe it."

Beteille sums up the history simply: "We didn't make any serious mistakes." Although he was the one who advised Pierson to go for a 50 percent market share, he observes today, "I never thought it would end up like this."

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THEY'RE COMING TO BRING YOU SAFELY BACK TO EARTH. MAYBE.

BY JAMES OBERG

In 1964, most viewers of televised space "shots," as they were called then, knew what it took to protect a spacecraft from the fire of reentry. It took big, heavy shields bolted to pressurized metal vessels. One of the most nerve-racking moments of the early space program had been the final minutes of John Glenn's 1962 Mercury flight, when Mission Control waited to learn whether his shield had remained attached to the *Friendship 7* capsule during the violent return.

Two years later, on June 10, 1964, another, much lighter vehicle entered the atmosphere with no one on board. In engineering terms it was nearly as daring as the Mercury flights had been. Launched on a sounding rocket to an altitude of 96 miles over New Mexico, the craft dove back toward Earth at a speed of more than 5,000 mph. Being so light, it didn't generate as much heat from atmospheric friction as Glenn's capsule had, so it had only a thin coating of thermal protection—no shield. Odder still, it was inflated like a balloon in a Thanksgiving day parade.

The contraption was called IMP, for Inflatable Micrometeoroid Paraglider. It was developed by a team at NASA's Langley Research Center in Virginia, led by a young project manager named Bill Kinard. Now 71, Kinard is still at Langley as a senior scientist. His paraglider, though, is all but forgotten.

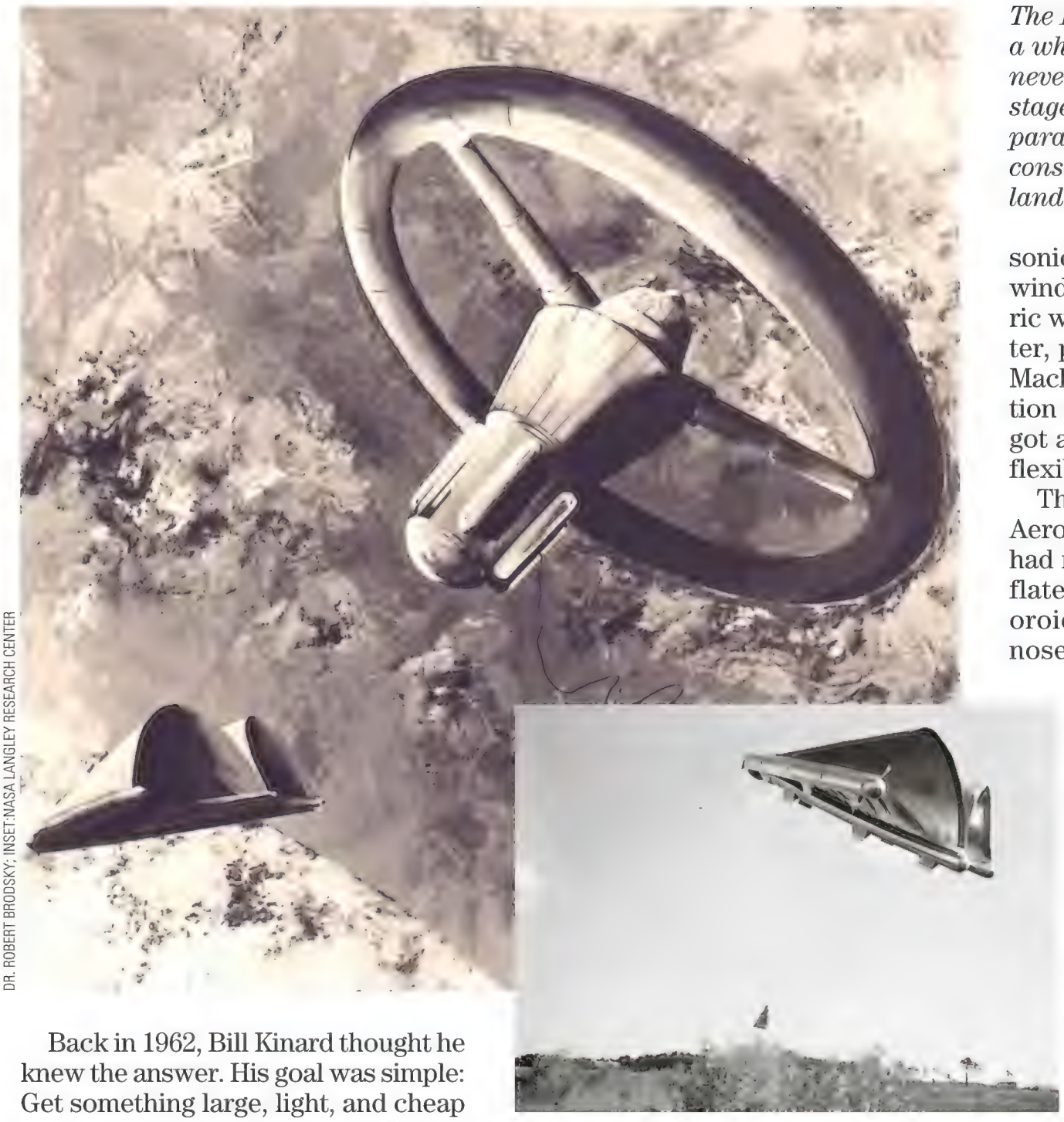
Now engineers on both sides of the Atlantic hope to see a distant descendant of IMP fly. A European-Russian team has built and tested, not altogether successfully, an inflatable reentry vehicle, and has scheduled another test for next spring. So far, their cone-shaped spacecraft appears capable of protecting an instrument capsule on the return to Earth. Designers have big plans for the invention, which has been dubbed Inflatable Reentry and Descent Technology. First, it would return cargo from the International Space Station. Eventually—if formidable technical and even psychological hurdles can be overcome—it could serve as a personal escape pod for astronauts forced to bail out from orbit.

With IRDT, the idea of inflatable spacecraft is experiencing, if not a renaissance, at least a curious second look after decades of false starts and periodic bursts of hot air. "Technically, inflatables are feasible," says retired NASA futurist Joe Loftus, who once headed the advanced planning office at the Johnson Space Center in Houston. "The question is: What is it that will make them desirable?"

Opposite: Ahead of its time? An inflatable spacecraft undergoes wind tunnel tests at NASA's Langley Research Center in 1962. A later suborbital test was inconclusive, but inflatables survive in current plans for space rescue vehicles (below).

OPPOSITE: NASA LANGLEY RESEARCH CENTER; INSET: RETURN AND RESCUE SPACE SYSTEMS GMBH

PEOPLE



DR. ROBERT BRODSKY; INSET: NASA LANGLEY RESEARCH CENTER

The FIRST lifeboat was designed for a wheel-like space station, which never got past the artist's-concept stage. Meanwhile, similar paragliders (inset) were briefly considered instead of parachutes for landing early space capsules.

Back in 1962, Bill Kinard thought he knew the answer. His goal was simple: Get something large, light, and cheap up above the atmosphere for just a few minutes, then return it to Earth safely. Scientists wanted to refine their models of meteoroid and micrometeoroid density in space so engineers would know how much protection to install on space vehicles. "We were interested in exposing large areas in space" to see how much bombardment they could withstand, Kinard says.

Rigid metal structures were too heavy and expensive, so Kinard's team turned to unconventional approaches. Langley had already come up with the inflatable Echo balloon, which had an aluminum-coated Mylar surface that in 1960 was used to bounce radio signals back to the ground. Another group at the center was looking at using a modified Rogallo wing (the famous prototype of the hang glider) as an alternative to parachutes for gently landing a Gemini capsule. To reduce weight, the engineers replaced the wing's metal struts with long cylinders made of tough fabric, which were inflated with gas until rigid.

Kinard's team liked that idea, and started working on a paraglider that would be inflated with compressed nitrogen and would have a large surface area that could be covered with sensitive electronic meteoroid detectors. After launch, the paraglider would separate from its carrier rocket, inflate, spend about five minutes getting pelted by meteoroids, then fly back through the atmosphere for a desert landing at the Army's White Sands missile range in New Mexico.

Early tests were encouraging. "I was amazed that a paraglider with a flexible canopy could fly so well at supersonic speeds," Kinard recalls. "We did wind tunnel tests, and the [wing] fabric was like a piece of metal—no flutter, perfectly stable." Flying at up to Mach 8 would generate heat from friction with air molecules, so the glider got a thin coating of silicone over its flexible Fiberglas fabric.

The actual flight of the IMP, on an Aerobee-150 sounding rocket in 1964, had mixed results. The paraglider inflated properly and collected meteoroid data. But the attached rocket nose cone failed to separate before reentry, so the glider began its descent through the atmosphere dragging an anchor. Amazingly, it righted itself and flew briefly, until the aerodynamic pressure got too high. At that point, one inflatable boom burst, probably from the stress of dragging the nose cone, and the IMP dropped to the desert like a wounded duck. It took days to find all the meteoroid collection panels that were torn off the wing as it fell.

So much for IMP. Scientists soon found another way to get micrometeoroid detectors into space—on test flights of Saturn boosters. But the idea of inflatable reentry vehicles had caught the imagination of engineers, including some outside NASA, who started musing about light craft that could make the return trip all the way from Earth orbit. "We did nothing intentional to inspire it," Kinard says, "but we got lots of attention."

One of those engineers was Robert Brodsky, who at the time was in charge of bringing in work to Aerojet-General's Space General division, which had built the Aerobee rocket. Aerojet had designed the electronics and other systems for IMP, while B.F. Goodrich had built the structure. Even before IMP's test flight, both companies started pushing the concept of inflatable reentry with their customers, primarily the De-

partment of Defense. In the early 1960s, the Pentagon was flirting with developing its own astronaut program (see "A Sudden Loss of Altitude," June/July 1998) and was interested in proposals for a small, storable craft that could return a person from orbit in a hurry.

"I got the idea that we could alter the IMP design sufficiently to turn it into a space lifeboat," Brodsky says. He saw it as an option for dire emergencies only, like a life raft on an oceanliner.

"There were only two reactions," Brodsky recalls. "Initially, sheer incredulity. Then—seeing the challenge—great enthusiasm." In 1962 the Air Force materials lab gave his company $250,000 to look into the concept; the funding later grew to $1 million. "In those days, that was a lot of money," he says.

The project lead was Jesse ("Bud") Keville, a 37-year-old engineer who set to work designing the lifeboat and building and testing components. Space General called it Project FIRST, for "Fabrication of Inflatable Reentry Structures for Test." Keville's team kept the basic IMP paraglider with its three inflatable struts, and placed a prone astronaut in the center strut. The lifeboat weighed a mere 850 pounds. Stowed on a spacecraft, it could fit in a three-foot by 10-foot cylinder; inflated, it was 23 feet long, with a wingspan of 28 feet. The engineers even came up with a deluxe three-person version, and a six-person model that weighed a ton.

The inflatable wing spars were made of nickel-chromium alloy mesh. For thermal protection, the mesh was saturated with liquid silicone and covered with another layer of silicone rubber. A vehicle returning from orbit would experience more heating than IMP had during its suborbital flight, and vacuum chamber tests showed that this material could handle temperatures of more than 2,000 degrees Fahrenheit. The wing material, says Keville, "resembled a lightweight burlap." At first he had trouble finding a textile company that could handle the tricky job of weaving metal yarn, but he finally found one called Prodesco, in Perkasie, Pennsylvania. Keville spent weeks in the small town, which had "only one general store and a Quaker church."

The FIRST lifeboat was designed to be folded up in a small container on the outside of a spacecraft. An astronaut abandoning ship would enter the pod through a small hatch leading to the outside. After inflating the paraglider with nitrogen fed through a hose or from gas bottles, the escapee would fire solid rockets in the central spar to deorbit the craft. The fall from orbit (400,000 feet) down to 120,000 feet would take half an hour, with attitude control jets used for maneuvering. Once it became aerodynamic in the lower atmosphere, the paraglider could be steered by changing the pressure within the inflatable spars to achieve a kind of wing-warping. The landing would take place anywhere within a footprint 450 miles wide and 1,400 miles long.

Five years of research convinced the FIRST engineers that the concept was feasible. Unfortunately, by the late 1960s it was no longer wanted. Neither Apollo nor Skylab, NASA's first space station, were in the market for a bailout system, and the Department of Defense was already starting to back away from plans for its own station. Inflatable lifeboats had become the answer to a question no one was asking.

From the beginning, Brodsky had had grander things in mind for FIRST, based on futuristic schemes that Wernher von Braun and others were espousing at the time. "[FIRST] was begun to meet an apparent need for a wheel-like rotating space station," he says. "It was terminated when it was apparent that we were too early. The idea of a [large] manned space station was no longer in vogue."

That hadn't stopped other engineers from exploring similar bailout concepts, though. Other companies had learned of the FIRST project, and throughout the 1960s they came up with various ways to improve on it. General Electric produced probably the most famous concept, called MOOSE (the acronym originally stood for Man Out Of Space Easiest, but the name was later changed to the more sober Manned Orbital Operations Safety Equipment). Instead of inflating the structure with gas, MOOSE engineers used fast-setting polyurethane foam to hold a conical shape; the hardware, which fit in a suitcase-like container and weighed 200 pounds, was even tested on a spacesuited volunteer.

Douglas Aircraft had a similar concept: Paracone, an inflatable shuttlecock-shaped structure made of Teflon-coated Rene-41 alloy fabric. The reentry vehicle was slowed to about 25 mph at impact, so no parachute was required, although the astronaut experi-

General Electric's MOOSE morphed into this concept for an Apollo escape pod, which replaced a foam-filled structure with a solid one. After a long fall from orbit, the astronaut would float gently to Earth under a parachute.

NASA S-67-6300; VIA NASM

DR ROBERT BRODSKY

In the early 1960s, companies like Aerojet-General tried to sell inflatables to the Pentagon. Here, technicians work on the Inflatable Micrometeoroid Paraglider (IMP) at the B.F. Goodrich plant in Ohio.

enced about 10 Gs of acceleration.

The inflatable designs often were met with the same reaction from potential customers and other outsiders. "They were skeptical," says Robert Kendall, who worked on Paracone at Douglas in the 1960s. He tried to overcome the doubts by pointing to inflatable structures used by the U.S. Navy: "I mentioned common, everyday inflatable structure applications such as truck tires, bags around payloads, vessel-side protective balloons."

It was still a tough sell, and remains so, even though the idea has resurfaced more than once since then. In Russia, engineers at the Babakin Space Center in Moscow turned to inflatables in the 1980s to produce lightweight vehicles for descending to Mars. The Mars 96 mission included an inflatable aerobraking system to slow down two small atmospheric-entry probes meant to study the Martian weather. But the spacecraft went off course immediately after its launch in 1996, crashing down into the Andes Mountains.

It was that project that led to current interest in inflatable reentry vehicles. While the Mars work was under way in Russia in the early 1990s, officials at the European Space Agency were eyeing a future need to return samples, film, tape, equipment, and other material from the proposed International Space Station (ISS). With cargo estimates running to nearly a ton a year, ESA managers realized that if they used NASA's space shuttle, they faced shipping charges exceeding $20 million annually.

Then Babakin, in partnership with the German aerospace company Astrium, knocked on the door with a concept for a low-cost ISS Download System, based on the Mars craft, that could return several hundred pounds at a time. In principle, it was similar to the Russian Raduga capsule, which had been used to bring material back from the Mir space station. But this system would be much lighter and cheaper.

ESA was intrigued enough to give the companies almost $2 million for the Inflatable Reentry Descent Technology program, which aims to prove the ability to bring back payloads from space inside an inflatable vehicle. First the team built a probe called Demonstrator to carry a sensor package weighing about 44 pounds. Engineers at Babakin designed a wastebasket-size cylinder to house the instruments and payload and surrounded them with a pair of inflatable shields coated with ablating material. The first "cascade," as the shields were called, was eight feet in diameter and would slow the vehicle during the first phase of reentry. A second, 14-foot cascade would open during final descent to soften the landing.

In February 2000, a test of the shielded probe came close to success. The Demonstrator hardware flew on the first test of the Fregat, a new upper stage for Russia's Soyuz rocket. Attached to the Fregat, the Demonstrator made five orbits at an altitude of 375 miles, then separated from the upper stage and inflated its first cascade. Tracked by Russian air defense radars, the vehicle descended as planned, enduring a maximum of 15 Gs, and landed near Orenburg, about 30 miles past the aim point. The good news was that temperatures inside the capsule had remained normal. The bad news was that the second cascade, designed to cushion the final impact, never opened. The Demonstrator hit the ground at 200 feet per second, essentially a freefall.

For the next test, in August 2001, the project bought a commercial launch piggybacked on a converted Russian missile that also carried a solar sail experiment for the Planetary Society, a U.S. space advocacy group. Both payloads failed to separate from the third stage, and neither had a chance to deploy. The inflatable reentry vehicle never even got an official name, and designers worked on making the separation mechanism more reliable.

The next test, called Demonstrator 2, was launched on the same three-stage Volna booster from a Russian submarine, with a planned landing zone in eastern Siberia's Kamchatka Peninsula. On July 12, 2002, the Volna rose from the Barents Sea and headed east into the predawn sky. Russian space officials immediately declared the launch a complete success and publicly confirmed the landing.

But as days passed without an actual recovery, Russian launch officials were forced to fess up: The 540-pound probe was lost. Accident investigators later determined that Demonstrator 2 had detached from its rocket too ear-

ly, at around the time Volna's second stage separated. "Because of the uncontrolled detachment," their report concluded, "no conclusions can be drawn on its further behavior and on any performance aspects."

That leaves the IRDT hardware still unvalidated after three tests. Project engineers have made a few minor fixes to their design and plan to try again next spring. So far, they've seen nothing that tells them the basic concept won't work. Astrium (now part of European aerospace giant EADS) and Babakin have even formed a joint stock company, Return and Rescue Space Systems, to produce and sell inflatable reentry systems. But after the loss of Demonstrator 2, Helmut Hoffman, head of the company's Russian office, told the Russian magazine *ITOGI*: "The question of the project's future financing will depend on the test results."

The IRDT's designers have a range of applications and spinoffs in mind for the new vehicle, if it can be made to work. Besides returning cargo from the space station, it could be used for jumping out of burning skyscrapers. And Dieter Kassing, ESA's IRDT program manager, has raised even more interesting possibilities: Talking to reporters following the failed 2002 test, he said, "I can imagine that this technology also could possibly be used for some sort of emergency and rescue mission for humans" in space.

In recent years, the notion of jumping from an orbiting spacecraft has been discussed only as an extreme sport. Rick Tumlinson, president of the California-based Space Frontier Foundation, calls it "orbital surfing." Bevin McKinney, an engineer who worked on the privately funded (and now-abandoned) Rotary Rocket concept in the 1990s, has also tinkered with designs for an orbital escape system. His proposal involves a large parachute-shaped aerobrake made of ceramic fibers, plus an inflated heat shield in front of the astronaut's body. "The trick is to come down very slowly from high altitude," he told a reporter for a skydiving newsletter in 2001.

Among those pushing for a space bailout capability is Robert Kendall Jr., son of the Douglas engineer who worked on Paracone in the 1960s. Together with his father, who retired in 1976, Kendall Jr. has patented several designs for inflatable air-drop systems. Department of Defense contracts on unrelated technologies kept the father-son team busy in the 1990s, but they continued to publish scientific papers advocating the use of inflatables for orbital reentry. Several years ago, says Kendall Sr., "we submitted a proposal [to the Air Force] to recover satellites, astronauts, microgravity experiments, and reusable launch vehicle components." They even proposed a test flight to return an instrument-equipped mannequin from orbit to a designated site on the ground. No one was interested enough to fund it.

Some aficionados of personal bailout systems still hold out hope that NASA will one day look in their direction. But so far, the agency's plans for a rescue vehicle for space station crews appear not to include one-person lifeboats.

FIRST designer Robert Brodsky still talks up the idea to pretty much anyone who will listen. He accuses NASA of being close-minded on the subject of inflatable reentry vehicles. "Lack of a mission need stopped the program in the '60s," he says. "But 'not invented here' in NASA is stopping it these days." Several years ago, he proposed that the agency update the old FIRST concept as a crew return vehicle, or CRV, for the space station. "They patted me gently on the head, because their idea of a space lifeboat is radically and very expensively different from mine," he says.

John Muratore, who until recently managed NASA's CRV program at Houston's Johnson Space Center, denies that the agency turned a blind eye to inflatables. "It's an interesting technology, and we have looked at it," he says. The problem, he says, is that "you chase a weight curve. You add weight to [withstand stress], so the heating goes up, and the vehicle gets bigger and heavier." His team studied a dozen designs and did a deep literature search. They heard from the inflatable backers. They just weren't convinced.

All of which leaves Brodsky, Kendall, and the other pioneers of inflatable concepts where they've always been. Despite the technology's interesting past and its promise for the future, it still doesn't have a great present.

Stephan Walther, the managing director of Return and Rescue Space Systems in Bremen, Germany, hopes that will begin to change with next year's test of the IRDT, and that a string of successes will eventually persuade ESA to pay for a full-up cargo system. As for inflatable lifeboats, "I'm personally convinced it's possible," he says, but adds that it will take a lot more research and engineering development before people are willing, literally, to climb on board.

The latest best hope for inflatable reentry vehicles is a Russian-European cargo craft due for its next test this spring. Below, engineers at the Babakin center in Moscow check out the vehicle and the payload.

LEFT: RETURN AND RESCUE SPACE SYSTEMS GMBH; ABOVE: ESA

Resto

Diamonds in the Wreck | Boeing 40C

Seventy-five years ago, Pacific Air Transport mailplane no. 5339 plunged into treetops over southern Oregon and burned, only to have its engine ripped out by a salvage team and then fall prey to townspeople who pilfered its remains and amputated its tail. Steeped in mountain fog and wet Northwest weather for six decades, the Boeing 40C eroded until its remnants, looking like the twisted bones of a great primitive biplane, were scooped from the Willamette Valley and cached in a horse trailer.

Despite all this misfortune, Spokane, Washington engineer Addison Pemberton is today spending $100,000 to make 5339 flyable again. "This airplane has an amazing history," he says. If he succeeds, his will be the only airplane of its type flying.

The 40C, a 44-foot-wingspan, 6,000-pound, open-cockpit behemoth, originated in a design Boeing entered in a 1925 competition to replace the Post Office's aging de Havilland DH-4s. Boeing lost the competition, but when the company lowballed bidding for Contract Air Mail two years later, a fleet of Model 40s began ferrying mail on two routes—San Diego to Seattle and Chicago to San Francisco—under the banners of the company's Pacific Air Transport and Boeing Air Transport divisions. In addition to 749 pounds of mail, each 40C could accommodate four paying passengers in two cramped cabins in the forward fuselage.

On the morning of October 2, 1928, Pacific Air Transport pilot Grant Donaldson took off in 5339 from Medford, Oregon, on his way to Portland with nine pounds of mail and passenger D.P. Donovan, a West Coast drugstore chain owner and a gemstone dealer who carried a satchel of diamonds. An hour into scud-running beneath low-lying clouds, Donaldson heard booming noises and discovered that he was scraping treetops. There was no time to recover. The 40C dove forward "as if it had been a giant scythe," reported the Roseburg, Oregon *News-Review*. "One tree, nearly a foot in diameter was cut off about 25 feet from the ground."

Donaldson rushed out of the cockpit as the biplane's nitrate-doped cotton skin fueled a fire so intense it melted the aircraft's metal propeller. He fought through the flames to check on his passenger, but saw that Donovan had been killed on impact. Donaldson's actions left him with severe burns; for the rest of his life he would have a scar tissue circumscription of flight goggles on his face. Bloody and incoherent, Donaldson staggered down to a highway, where a preacher and his family hurriedly drove him to a pharmacy nine miles north, in Canyonville.

"The next day the airline went up there and they got the remains of poor Donovan," says Pemberton. "They picked out what diamonds they could, and they salvaged what they could of the engine." For years afterward, townspeople hiked up to the crash site to sift for diamonds. (Rumors abound of Canyonville wives who own rings set with diamonds from the crash.) In 1929,

COURTESY ADDISON PEMBERTON

HEATHER EVANS (2)

Above: Addison Pemberton and his team survey 5339's remnants at Spokane, Washington's Felts Field in 2000. Right: The Model 40C's rudder pedals are engraved with Boeing's "bug" logo.

The fuselage is mounted on a rotating jig powered by a garage door opener so that team members can work easily from many angles.

r a t i o n

they hacksawed the tail section off to use as a nursery school jungle gym.

Pemberton first grew interested in restoring a Boeing 40 after seeing one at the Henry Ford Museum in Dearborn, Michigan. He researched the fates of all 81 Model 40s built and in 1982 began a two-year hunt for 5339's hulk. As luck would have it, a remark published in a 1999 magazine profile of his restored Beechcraft D-17 Staggerwing caught the eye of a member of the Oregon Aviation Historical Society, which had scavenged 5339's parts over several trips in the mid-1990s. "I just casually mentioned that my lifetime dream had been to acquire and restore a Boeing 40," Pemberton says. The OAHS member told him that most of the crash was in a horse trailer in his backyard. Pemberton struck a deal: He traded the society a propeller and $5,000 for the parts, and promised to restore 5339 to its original livery and exhibit it to the public.

Though Pemberton had restored 18 aircraft, none had been as ravaged as this one. "I tease him about it—that he didn't bring a project home, he brought home DNA," says his wife Wendy, who does fabric work for his team. Perhaps 50 original pieces will be absorbed into a 30,000-part aircraft, making the effort more a cloning than a restoration.

The reusable parts—all made of the alloy chromoly steel, durable enough to survive 5339's prolonged exposure—included the cockpit entry steps, the wobble pump, and seat brackets. "If it wasn't a structural part, we'd try to incorporate it into the airplane," says team member James Love. Wood from the wreck has been salvaged and combined into new gussets and cross-strips.

When parts have had to be fabricated, the team has benefited from 600 schematics on microfiche preserved by former Boeing employee Harl Braken. Years of work have been saved by using a device called a water jet, which cuts metal plates with a 50,000-pounds-per-square-inch stream of water. Three years into the seven-year project, the cockpit and instrument panel, control systems, wing ribs and fittings, oil tank, engine mount, fuselage, and mahogany-accented cabins have been restored.

What's left? "We have to construct the tail flying surfaces," says Pemberton. "We have to do the final assembly and completion of all the wing panels, scratch-build the landing gear, and finish the sheet metal."

Since Pemberton owns the manufacturer's data plate and has technical drawings to prove 5339's conformity to the original design, the Federal Aviation Administration will be able to classify the aircraft as a standard—not experimental or a replica—though that may be stretching things, suggests welder Ernie Buckler. "If you have the [data plate], you can put a new fuselage, new wings, new tail, new engine, new cockpit, new instruments," he laughs, "and it's still the same airplane."

—Sam Goldberg

BOEING ARCHIVES

Right: Passengers board 5339 three weeks before its 1928 crash. Below: Pemberton and son Ryan discuss the aircraft's trim system.

HEATHER EVANS

FROM AN ISOLATED ALASKAN OUTPOST, **RC-135 CREWS**

EXPERT WITNESS

SNOOPED ON SOVIET MISSILE TESTS.

BY ROBERT L. BROWN

When I stepped off the Boeing KC-135 tanker that had brought me to my new duty station in 1968, I felt as though I had been transported back in time. I stood on a heavily patched aircraft parking ramp in front of a large, weather-beaten wooden hangar, marked with a sign that read "DET. 1 SHEMYA." Scattered around the landscape were the wrecks of a few battered military trucks and other vehicles and old concrete gun emplacements—some with rusted barrels still pointing out to sea. The decaying fuselage of an old bomber lay just off the runway where we had taxied in to the hangar turnoff. A crust of ice and snow, which I was to learn never went away, covered the ramp, and a chilly wind of close to 30 mph was blowing steadily across the treeless tundra and rock that made up this small Aleutian island—my home for the next year. Everything was either stark white or some shade of black, as if the whole thing were a scene from an old newsreel.

At only about three or four miles long and a few miles wide, Shemya doesn't show up in the average atlas. Located near the end of the Aleutian chain east of the larger island of Attu, its value lay in its proximity to Soviet missile testing ranges.

I was an electronic warfare officer (EWO) who had cut my teeth on B-52G bombers at Warner Robbins Air Force Base in Georgia, where life consisted of alert duty, long training flights, and endless preparation for either nuclear war or inspections—both about equally dreaded. On the B-52, the EWO's job was to defend the bomber from fighters and ground-to-air missiles by jamming tracking radars, dispensing chaff and flares, and, when those efforts failed, advising the pilots that they needed to resort to violent maneuvers.

Until the B-52s lumbered into battle over Hanoi during the Vietnam War, electronic countermeasures had not really been tested in combat. Uncertainty about whether they would work, coupled with the mystery and weirdness that most people associated with electronic countermeasures at the time, made the EWO something of an oddball in the bomber world. The fact that EWO was pronounced "e-woe" didn't help.

But in the RC-135s at Shemya, electronic warfare officers were called Ravens and were central to the mission. They located, analyzed, and recorded Soviet radar signals—real time, real world. They gathered data on the strategic missile tests the Soviets launched from sites in Plesetsk, Tyuratum, and Baikonur toward the vast Kamchatka test range.

I didn't know much about the RC-135 Ravens when the squadron operations officer called and asked if I was interested in flying on a different aircraft. He couldn't tell me much about the assignment, as everything was classified, but I was bored with continuous alert duty on the B-52s and more than a little frustrated with my second-class standing in a pilot-dominated bomber culture. "What the hell," I answered. Things moved fast after that.

I was assigned to the 24th Strategic Reconnaissance Squadron of the Sixth Strategic Reconnaissance Wing, located at Eielson Air Force Base in Alaska. Arriving at the beginning of winter, I discovered a place where the sun—what there was of it—rose grudgingly a few hours before midday and set a short time later, where moose strolled into back yards, and the landscape went on forever.

Most of us were married, and we lived on base in ghetto-like apartment clusters. Living in Alaska made you feel isolated, a sensation made worse by our being cut off from our extended families. Air crews on normal tours of duty spent one week at Eielson and

With its brutal cold and high winds, Shemya Air Force Base was a lousy place to fly from. Its value was its location—an hour by air from the Soviet's Kamchatka test range.

BELOW: COURTESY KING HAWES; OPPOSITE: BRUCE DALE, NATIONAL GEOGRAPHIC, GETTY IMAGES

COURTESY ROBERT L. BROWN (2)

Ravens on board: An unofficial patch marked the electronic warfare officers who nested inside the RC-135's antenna-prickly fuselage.

the next at Shemya—in short, we would spend six months out of the year at the austere environs of Detachment 1. Wives knew nothing about their husbands' work.

The heritage of our missions extended back to 1946, when a modified B-17G flew the first flight to gather electronic data on the Soviets. By the end of the cold war, U.S. Air Force and Navy crews would have flown 20,000 clandestine missions near Soviet airspace, gathering all manner of electronic intelligence (ELINT) and signals intelligence (SIGINT).

In the late 1960s, there were about a dozen RC-135 airframes in the Air Force fleet, mostly one-of-a-kind types, configured for specific areas and intelligence collection missions, and often with their own code names. The RC typically had heavy antenna pods in the cheek fairing, forward of the wings. It also had a long radome, which inspired the RC's nickname, Hog Nose.

Shemya crews operated two airframes: the RC-135E "Lisa Ann/Rivet Amber" and the RC-135S "Rivet Ball." Rivet Amber was fitted with a huge side-looking radar in the forward fuselage, behind a fiberglass radome that ran from the cockpit to the wing root. It was also unique in having a "fifth" engine—a Lycoming T-55-L5 turbine hanging under the left wing solely to furnish power for the radar, which emitted a beam that could detect incoming intercontinental missiles above the atmosphere and hundreds of miles away. The radar was so powerful it endangered anything in its path.

Our crew flew the Rivet Ball—tail number 1491—which had the hog nose and antenna stubs. Most of our sensing equipment was installed on the right side of the aircraft, which featured three distinctive di-pole "spear" antennas on pylons, as well as a row of 10 large round windows. The first five were quartz, and the rest optical glass, for the various cameras we carried. Also on the right side, located between the words "Air" and "Force," was a black square—a special window for a gyro-stabilized camera with a plate glass negative that shot the stars during target tracking. On the top and center of the fuselage, a recycled B-29 gunner's plexiglass dome served as the manual tracker's position. The fuselage around the base of the dome was painted black to cut glare, and the top of the right wing was also painted black, along with the inboard sides of the engine 3 and 4 nacelles. Even with the anti-glare paint, the dome was hot and cramped. Still, with its panoramic view, it was the best seat in the house, and this became my position.

The Rivet Ball had two Raven teams, each consisting of seven or eight officers who collected electronic and telemetry data and two noncommissioned photo technicians, who loaded and downloaded the cameras and packaged the collected data, which was shipped to Wright-Patterson Air Force Base in Ohio for analysis. An enlisted electronic warfare technician also helped the team, taking care of the signal and telemetry collection equipment, downloading the recorders, and helping prepare the data. There were also Air Force Security Service personnel—Russian linguists—who flew with the team to collect voice communications and listen to Soviet radio chatter. Because we relied on each other so heavily, the members of each team were fiercely loyal to one another. The two teams were friendly but highly competitive.

The Ravens on my team—Team 2—also had personal call signs, bestowed by team members based on personalities and appearances. Our tactical coordinator (TC) was Captain Robert "Granny" Armentrout, a careful and deliberate professional who coordinated the mission in the air and was the team's link with the pilots and navigators. Working closely with the TC was the signal monitor, Captain "King" Hawes, who had the best technical mind on the team and was also sometimes called "Tinker," because he was constantly taking things apart or thinking up ways to modify the equipment. Raven 1 was Captain Al "Lurch" Hansen, a guy over six feet tall who looked even bigger in his oversized parka, military mukluk boots, and fur cap. Raven 2 was Captain Joe "Preacher" Hall, a gentle good ol' boy from Louisiana who took his

job and his religion seriously. Captain Ed "Mother" Wakeman was Raven 3, a former non-commissioned officer who had come up through the ranks and had been in RB-47Hs since God was a copilot. Mother was a Connecticut Yankee to the bone and took care of most of the housekeeping chores, from paperwork to refueling the crew truck to making the coffee every morning in the crew lounge. Raven 4 was Captain Russell "Gort" Howard, a former B-52 EWO who had been in my squadron in Georgia. Gort was a happy-go-lucky type with a good sense of humor. Captain Brad "Troll" Perry initially served as one of the team's manual trackers (MT), then switched to backup signal monitor after the solar radiation began to affect his eyes. The Troll got his name from his habit of holing up in his room between missions to work on his graduate degree. I was the primary manual tracker, and despite my genteel southern roots, I ended up with the handle "Viper," a title bestowed by Mother, who claimed that I tended to be a bit of a wiseguy—which of course was the sort of total exaggeration you would expect from a damn Yankee.

Shemya was not as cold as Eielson, but the weather was consistently bad, and we routinely took off and landed in minimum safe conditions with crosswinds, blowing snow, and limited visibility. The hangar door had a sign saying "Do Not Open When Winds Are Above 50 mph." Takeoffs were often made between wind gusts that exceeded the maximum allowed by the book; pilots who flew in and out of here were rated "Shemya-qualified," almost like carrier pilots.

There was only one operational runway at Shemya, which was around 10,000 feet long, but there were no overruns. At one end was a dropoff of about 40 feet into the tundra. This was the good end. At the other, a steep cliff plunged 50 to 60 feet into the rocks and surf. (I would come to a unique understanding of the hazards of this treacherous and icy concrete strip when Rivet Ball was eventually destroyed in a landing accident. Luckily, all of us walked away.)

The area we orbited was near the Kamchatka test range, where the Soviets fired their test missiles, and about 280 miles from Shemya. Since the Soviets weren't in the habit of coordinating their tests with us, we learned of the possibility of a launch only hours before it was to take place, from an alert system so classified that the details were above even our security clearances.

When we got the word that a shoot was developing, the klaxons would blow, and we scrambled to get the airplane out of the hangar and in the air as fast as possible. Engine runups and equipment checkouts were quick and dirty. There was a narrow window of opportunity to get in position near Kamchatka to intercept the reentry vehicle, called the RV, as it plunged through the atmosphere into the range. Thanks to the air and ground teams, we rarely missed a shot. We did, however, tend to be a somewhat motley-looking bunch at times. While we normally wore regular-issue flightsuits, because of the secret nature of our work, these were stripped of any rank or unit patches, and with a scramble coming at any time, at least a few guys usually ended up flying in whatever they happened to be wearing. Jeans and sweat shirts were common, with headgear ranging from regulation caps to knit watchcaps and Russian-style fur-lined affairs with ear flaps.

It took a little over an hour to get from Shemya to the waters off Kamchatka, where, depending on how good our alert warning had been or how bad the weather was, we would usually spend anywhere from a few minutes to an hour maneuvering to be lined up properly at the north end of the area just before the RV appeared. As the RV

The author (right) left the monotony of B-52s to become a Raven. Below: Rivet Ball's interior after a crash off Shemya's ice-slick runway.

COURTESY ROBERT L. BROWN (2)

entered the range, we'd turn south and run parallel to the coastline. If we were late, we missed part or all of the event. If we were early, we ran out of tracking space and lost the target behind us.

Each Raven monitored and recorded missile telemetry, the data link channels of the incoming RV, or the signals from the ground-tracking radars used by the Soviets to monitor the test firing. But ultimately, all the electronics and calculations boiled down to the eyeballs of the manual tracker, who was akin to the lookout in an old whaling ship's crow's nest. He aimed the row of specialized cameras mounted on the floor and pointing out the windows, but before anything got photographed or recorded, he had to spot the RV as it hit the atmosphere and began to heat up. When he did, he called "Gaslight!" — alerting the team that we had a target and to start data collection. At this point, things got very busy. The Ravens were recording everything that was going on, the pilots were trying to keep the aircraft as steady as possible, the navigators were keeping the aircraft on track, and the tactical coordinator was sweating out the time left before we ran out of track. The manual tracker was trying to keep the RV centered in his crosshairs.

Detecting the RV in time to alert everyone was critical, but the real trick was to track the actual warhead and not be fooled by all the burning fuel tanks and shields that the missile shed as it started to burn its way into the atmosphere. The MT had only a few seconds to locate, lock onto, and track the warhead, which was smaller, faster, and dimmer than the debris. It was easy to get behind the warhead and end up with a lot of useless film and data. I got bit at least once, but you learn fast on the job, and I usually got enough data to keep the intel and technical people happy. Being a southern boy who had grown up hunting fast flying dove and quail also helped, but I was never completely happy with the Rivet Ball's aiming and tracking system, which was basically a modified B-29 machine gunner's position with a simple optical sight and set of tracking handles. This setup was fine for firing .50-caliber bullets at a fighter half a mile away, but left something to be desired when it came to trying to precisely track a missile nose cone that was only a pinpoint of light. King (Tinker) Hawes experimented with a rifle scope he had bought himself and mounted on one of the window cameras, and the Troll actually used this setup on one mission with good results. But when I took over the MT position we still had the old system, and this is what I used during my time on Rivet Ball.

I discovered that the manual tracker's biggest problem was the sun, which heated up the plexiglass-domed cockpit like a rotisserie oven. The sun was usually shining almost directly into one or both eyes. Sunglasses didn't help; they made it harder to spot the RV warheads, so I resorted to sticking a square of paper about the size of a playing card behind the left lens of my glasses to block out some of the sun's glare. It was a half-assed solution.

By the end of a typical mission, a manual tracker would be seeing spots; by the end of a tour of duty he could have permanent retina damage. We complained to the Air Force, but ultimately—as we often did at Shemya—we improvised a solution.

Not surprisingly, it was King Hawes who figured one out. He found a spare plexiglass dome somewhere in the hangar and dragged it into my room, along with several rolls of heavy-grade aluminum foil liberated from the mess hall kitchen. We put the dome—which was about three feet in diameter—upside down on my bed and laid strips of foil inside until we had built up a metal shell. We then carefully removed the shell from the plexiglass and carried it to the aircraft, which was parked in the hangar just outside our rooms. After careful folding, maneuvering, and some verbal assistance, we finally got the shell in. It fit pretty well, except of course that I couldn't see out. King then cut out a section overlooking the right wing, and I had my sighting window. The result was crude and would have given the real engineers fits, but the shell worked, reflecting the solar rays and blocking the glare. The only drawback was that it also blocked the nice all-around view I normally enjoyed on takeoff and landing. I wasn't supposed to be in the dome during takeoffs or

Rivet Ball's Team 2 was an eclectic mix of roles and personalities, including signal monitor and resident tinkerer King Hawes (back row, right) and Raven/worry-wart Ed "Mother" Wakeman (front row, right)

COURTESY ROBERT L. BROWN

landings because the position wasn't reinforced to withstand an accident, but when you're young you think you're bulletproof. In any case, I had to give up the fun of watching everything from on top of the airplane and take my seat below for takeoffs and landings, as I should have been doing all along. This probably saved my life.

On January 13, 1969, we slid off Shemya's icy runway, sailed over the 40-foot drop, and slammed into the downslope. Equipment racks tore loose from the walls, black boxes were ripped out of the consoles; the noise was deafening. The impact broke the airplane's back, tearing open the fuselage aft of the wing. I'm glad I wasn't in the dome.

A more persistent danger than that of icy runways came from our target. The Soviets knew we were spying on their tests, of course, and monitored our flights closely. They would often have fighters in the area, and we knew that they would have loved an excuse to nail an RC-135. An RC is no match for a MiG, and since they had downed an RB-47H in 1960, we weren't about to give the Soviets the opportunity to set up an intercept and shoot us down. Between 1946 and 1991, the Soviets destroyed 18 types of U.S. reconnaissance aircraft; about 250 airmen were killed in shootdowns, lost their lives in accidents, or were captured (see "Beyond the Iron Curtain," Aug./Sep. 1994). The perils for reconnaissance crews didn't stop after the cold war: Earlier this year, four North Korean fighters intercepted an RC-135S over the Sea of Japan. Pentagon officials initially said that at least one of the jets locked its missile radar on the RC before the fighters dispersed, but that statement has since been retracted.

The risks aside, everyone knew the mission was important and worth whatever it took to collect the data. In October 1968, we hit the jackpot. We had taken up our position off Kamchatka, and all indications were that an event was developing. I spotted the incoming missile warhead, called the signal, and centered the crosshairs just ahead of the burning tankage. Suddenly I realized that there wasn't one warhead but three—it was a multiple reentry vehicle, or MRV (pronounced "merv"). U.S. intelligence agencies, including the CIA, had suspected the Soviets were developing a multiple-warhead capability, but we had not been able to prove it, and of course they denied it. If the Soviets had developed MRV capability, that would be an ominous turn, one that would affect ongoing nuclear arms talks. We had found the holy grail of the RC-135S mission—but when it happened, I damn near blew it.

Nobody had explained what I was supposed to put the crosshairs on, and I wobbled them all over the place. Somehow I managed to get enough data to confirm that we had spotted a MRV. The other Raven team was now anxious to pick up the next MRV shot and share the glory. But as it turned out, Team 2 was in the air for the second MRV test, conducted on December 18.

We knew it was an important discovery, but from our chilly Alaskan outpost, we didn't realize the magnitude. Sometime later, we were called into a classified briefing room and shown a film of the United States representative at the United Nations confronting the Soviet representative with proof that the U.S.S.R. had developed and tested multiple warheads for its missiles.

In his hand he had the photos and data from our missions. Team 2 had hit the mark.

Russian Evolution

Just as Boeing 707 and KC-135 airframes were made into a wide array of variants, including the E-3 Airborne Warning and Control System (AWACS) and the RC-135, the Tupolev Tu-95 Bear strategic bomber, which entered service in 1956, spun off many versions.

Over its 30-year production run, the Bear, developed from the Tupolev Tu-4—itself a copy of the Boeing B-29—was produced in electronic intelligence gathering, airborne test, photo-reconnaissance, and communications relay versions for the Soviet, and later Russian, air forces. For the navy, the Tu-95 was modified into the Tu-142 anti-submarine aircraft, and for the civilian airline Aeroflot, it was made into the Tu-114, which featured a new fuselage but retained the Bear's wings, main landing gear, and engine assemblies, as well as a nearly identical cockpit. The design came full circle when Tupolev used the Tu-114 and later -116 as the basis for new military versions, including the Tu-126, an airborne-radar craft with a large rotating antenna, similar to a Boeing E-3 AWACS.

When the Bear became vulnerable to ground-based air defenses in the 1960s and 1970s, it was transformed into a platform for deploying air-launched cruise missiles, or ALCMs, capable of striking targets far over the horizon. In this role and in its longstanding avoidance of the scrap heap, the Bear is like its principal cold war rival, the equally long-lived Boeing B-52.

—John Sotham

TASS/SOVFOTO

Like the KC-135, the Tupolev Tu-95 (here flanked by two Sukhoi Su-27s) spawned dozens of variants and has served for more than 40 years.

SIGHTINGS

They loved to look at Concorde. French photographer Etienne de Malglaive says, "For the French, the Concorde is a French aircraft, a part of our industrial heritage like the cruiser *Normandie*. For the British, Concorde is a pure British aircraft. The true fact that Concorde is a 50-50 bi-national product remains quite insignificant to most people of both countries." Last May 29, de Malglaive documented the devotion: Hundreds of Concorde fans stood outside the perimeter fence at Paris–Charles de Gaulle airport waiting for Air France Flight 001 to return from New York's John F. Kennedy airport, the aircraft's penultimate scheduled flight. When the delta-wing silhouette finally came into view, de Malglaive was ready to photograph the cheering fans (far right).

Two days later, Air France ended 27 years of supersonic service, and de Malglaive caught flight attendants enjoying their moment in history (right) on the wing of the Concorde that flew the last chartered flight, a 100-minute loop around the Bay of Biscay sold to patrons who wished merely to experience supersonic flight.

One last Air France flight remained: The Concorde that inaugurated Air France's supersonic service flew on June 12 from Paris to Washington-Dulles International Airport in Virginia, where photographer Eric Long used the airplane's sculptural profile to frame Eero Saarinen's sculptural terminal (below). The airliner will be displayed at the National Air and Space Museum's new Steven F. Udvar-Hazy Center. The center will open December 15.

British Airways plans to retire its Concordes this month.

The Story of the Boeing Company

by Bill Yenne. AGS BookWorks, 2003. 288 pp., $45.

BOEING

Known as Texans in the U.S., North American Harvards served as trainers for the British Commonwealth during World War II. They are now part of Boeing's history.

In spite of its grandiose title, *The Story of the Boeing Company* shows that there isn't—and couldn't possibly be—just one story. In fact, one must study the book's subway-system-like map of a merger chart to comprehend all the companies Boeing has gobbled up over the past 77 years. For those who haven't kept track, McDonnell's Phantom II fighter and Mercury capsules, Hughes Helicopter's Apache, Rockwell's space shuttles, and seemingly every other name-brand airplane, missile, and spaceship are now officially—if not genuinely—part of the Boeing company's saga.

Author Bill Yenne accomplished no small task when he assimilated an industry-size chunk of history into a coffee table book. Unfortunately, it occasionally comes close to crossing the line between useful reference and corporate bragging. For instance, it's an important revelation that the Douglas (now Boeing) A-4 Skyhawk flew in more major wars than any other aircraft, but including the fact that two T-45 Goshawks "accumulated 112 catapult launches and 112 arrested landings" during testing, or that an Air Force lieutenant called the McDonnell Douglas (now Boeing) F-15E "the best damned fighter in the world" is a bit superfluous. And Yenne's matter-of-fact tone, oft-repeated phrases, and a dance of military designations and re-designations can put readers in a daze; on a random page you can find passages like "The U.S. Navy, which had ordered 77 SNJ-1 and SNJ-2 scout trainers (NA-52) based on the BC-1, placed an order for 270 NA-77s to be delivered as SNJ-3s."

Indeed, *The Story of the Boeing Company* rarely strays from the realm of product orders and wartime performance capabilities; the author has quietly eviscerated the Boeing story of controversy and disappointment—essential parts of any history. There is little about how the Douglas DC-3—now part of *der Übercompany*'s legacy—all but wiped Boeing's Model 247 off the map. Boeing's failed entrant in the Joint Strike Fighter competition is succinctly spun: The "X-32 program has accomplished a great deal, especially with regard to direct-lift technology, that would benefit future Phantom Works projects." And the company's move of headquarters from Seattle to Chicago in 2001 is mentioned just once in passing.

Biographies of CEOs and engineering visionaries such as Bill Allen, Ed Heinemann, and the Douglases are sprinkled throughout the book, but are too brief to show the magnitude of these executives' management and ideas. On the other hand, it would have been nice to see more factoids like the sidebars about the hydrofoil warships and cars for San Francisco's and Massachusetts' light rail systems that Boeing manufactured, or the fake neighborhood that Boeing built atop Seattle factories during World War II to confuse any Japanese bombers.

Even with an unremarkable layout—clean lines, right angles, and even spacing all around—*The Story of the Boeing Company* is a pleasure to leaf through. There isn't a single page without an inset, image, or chart showing production runs for specific aircraft variants. Its photographs are crisply reproduced, though not always engaging, especially as subjects become more current. Fantastic shots of early Boeing flying boats and piston-engine warcraft far outshine military-magazine-quality photographs of modern fighters and uninspired snapshots of Boeing's jetliner family.

In fairness, nothing less than a television mini-series could thoroughly

encompass Boeing's now-sprawling history, and clearly, such depth wasn't the goal. Yenne's work is a feel-good production that will appeal greatly to thousands of current and former Boeing employees. *The Story of the Boeing Company* is positive reinforcement in print, and for that purpose, it's spot-on.
—Sam Goldberg is an associate editor at Air & Space/Smithsonian.

The Big Splat: Or How Our Moon Came to Be

by Dana Mackenzie. John Wiley & Sons, Inc., 2003. 232 pp., $24.95.

This book could have been called *The Giant Impact*, the term the author uses for the collision between Earth and a speeding Mars-size planet that is believed to have created the moon. Or it could have been called *The Big Whack*, as the event is less formally known. But for Dana Mackenzie, an imaginative science writer who has a Ph.D. in mathematics, *The Big Splat* is more evocative of an unimaginable explosion, equivalent to trillions of hydrogen bombs, that totally disfigured Earth and sent many trillions of tons of debris into orbit, where it eventually cooled and coalesced to form what some astronomers call the fifth inner planet.

Indeed, it is the unimaginable nature of such an "event" (as scientists call ungraspable, brain-numbingly large explosions like the Big Bang and the asteroid hit that did in the dinosaurs) that forces writers like Mackenzie to reach for metaphors. So he describes an Earth turned into a lopsided blob, spilling its guts like a watermelon shot with a rifle, or that most creepy and untidy of all microorganisms: the amoeba.

The giant impact theory is one of four that describe how the moon came to be, all of them standard fare in Astronomy 101. The author wisely gives plenty of space to the other three—the moon came from someplace else and was "captured"; it was formed with Earth in the beginning; or it is the amalgamation of small planetesimals that were caught early on in Earth's "feeding zone"—but he offers persuasive evidence that the Big Splat did the deed.

To his credit, Mackenzie makes it clear that the giant impact theory is not new; it dates back to the middle of the last century and was later championed by a succession of planetary scientists, including William K. Hartmann, Alastair Cameron, and Ralph Baldwin. He's assigned himself the job of telling the story, and he has done it admirably and accessibly, though with more background about Aristarchus, Galileo, Kepler, and Pythagoras than is necessary.

If *The Big Splat* validates the giant impact theory, it less obviously but still importantly also validates the science rationale for the Apollo program. Mackenzie, again wisely, credits science with being the longest-lasting accomplishment of Apollo. The giant impact hypothesis was only proven, he maintains, because scientists inspected the lunar surface first-hand and drew intuitive as well as scientific conclusions. Ultimately this knowledge—not a short-lived propaganda victory over the Soviet Union—is what Apollo gave all mankind.
—William E. Burrows, the author of This New Ocean: The Story of the First Space Age, *is a contributing editor for* Air & Space.

EXCERPT

from **The Wright Brothers and the Invention of the Aerial Age**

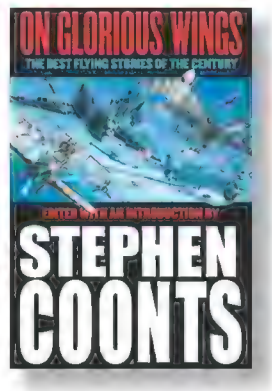
by Tom D. Crouch and Peter L. Jakab. National Geographic Books, 2003. 240 pp., $35.

Any thoughts of abandoning their aeronautical experiments were finally erased when Wilbur received an invitation [in 1901] from Octave Chanute to speak in Chicago before the prestigious Western Society of Engineers on their recent gliding experiments at Kitty Hawk. Though flattered by the invitation, Wilbur had never spoken publicly on aeronautics and was apprehensive about presenting a lecture to a group of professional engineers. With the encouragement of Orville and Katharine, Wilbur graciously accepted the opportunity with a self-effacing reply to Chanute, agreeing to deliver "a brief paper of a rather informal nature" at the Society's next meeting.... As the date of Wilbur's talk approached, his brother and sister queried him on whether the speech was to be witty or scientific. Wilbur quipped he thought it would be "pathetic."

On Glorious Wings: The Best Flying Stories of the Century

edited by Stephen Coonts. Forge Books, 2003. 464 pp., $27.95.

To carry out his mission of assembling "the best flying stories of the century," former U.S. Navy aviator and Vietnam veteran Stephen Coonts enlisted a platoon of literary heavyweights, among them William Faulkner, John Hersey, James Michener, and Joseph Heller. There's also Len Deighton, Louis L'Amour, Frederick Forsyth, and, not surprisingly, Stephen Coonts. What will surprise readers are flying stories by Edgar Allan Poe, Arthur Conan Doyle, and Rudyard Kipling.



On Glorious Wings is a thoughtful, chronologically organized collection that enables Coonts to guide the reader through the airplane's changing roles, from the time when flight was an amusement, through the airplane's transition from toy to weapon, and on to airborne technology of today and the future. Many of the 23 selections are familiar. Among these are "The Raid" from Hersey's *The War Lover*, and the short, powerful "For Want of a Fokker" from *The Blue Max* by Jack D. Hunter.

Some are better than others, but even the lesser efforts, such as General H.H. "Hap" Arnold's breathless tale of a young man's first flight, are enjoyable. Had the air pioneer and U.S. Air Force Chief of Staff's military performance matched his skills as a boys' adventure writer, Hermann Goering might have retired to Palm Springs instead of poisoning himself. Louis L'Amour, a writer of westerns, contributes a pulp fiction piece, "Wings over Khabarovsk," one of the volume's lighter stories, in which soldier of fortune Turk Madden and his loyal sidekick, Shin Bao, deal with sinister Russians in a situation reminiscent of B westerns of the 1940s.

It was good to re-encounter V.M. Yeates, who wrote *Winged Victory*. His excerpt, "Learning to Fly," demonstrates

why he has few peers in first-hand aviation writing. Coonts' own snippet, from *Flight of the Intruder*, describes the loss of a wingman in combat and reminds us why Coonts deserves his popularity.

Conspicuously absent is any entry from *Sagittarius Rising* by Cecil Lewis, the World War I British flier who set the standard for pilot-written narrative. For nostalgia's sake, something from Quentin Reynolds or Arch Whitehouse, writers who steered thousands of young men skyward between the two world wars, would have been welcome. Anything from Derek Robinson's *Goshawk Squadron*, a darkly comedic work about World War I, would have pleased more than the excerpt from Joseph Heller's *Catch-22*, "Chief White Halfoat," which falls flat among its competitors. In the main, however, the book succeeds.
—William Jeanes lives in Pass Christian, Mississippi, and is a former editor-in-chief of Car and Driver.

FLIGHT SIMULATOR

Flight Simulator 2004

Microsoft, $54.95.

Given the pressures of the marketplace and the excitement surrounding the centennial of the Wright brothers' achievement at Kitty Hawk, perhaps *Flight Simulator 2004* was inevitable, if not necessary. After all, the enormously popular and successful franchise reached a state of near-perfection with its last release, *Flight Simulator 2002*, a program that gracefully blended stunning graphics and smooth flight models into a simulation that was as beautiful to look at as it was a pleasure to fly. So the first question is: Why bother?

Flight Simulator 2004*'s Ford Tri-motor and Boeing 747.*

FS 2004 is not a wholesale overhaul of its predecessor. Instead, Microsoft wisely decided to build upon the program by offering a few nice tweaks for diehard simmers while hewing to this year's "Century of Flight" theme with the inclusion of nine historic aircraft—the Wright *Flyer*, Vickers Vimy, Ford Tri-motor, and Douglas DC-3, among others. Exactly how true-to-life are these simulated aircraft? Few will ever know. More to the point: How many gamers are really going to try to recreate Lindbergh's 33-hour transatlantic ordeal? Those who do deserve medals, or better yet, should have their heads examined.

For those unacquainted with the history behind these airplanes, the best part of *FS 2004* is writer Lane Wallace's collection of articles, each of which richly describes the aircraft, its designers, the pilots who flew them, and some of the flights that made aviation history. It is here one learns how unimaginably difficult, risky, exhausting, and uncomfortable these feats were.

After the novelty of the historic airplanes wears off, longtime fans will appreciate improvements to the program's basic features. Chief among these is a more dynamic weather system. Clouds are thicker, fuller, and can dissipate or build up over time. Turbulence varies by cloud layer, and players can select weather "themes," or enable automatic updating over the Internet that mirrors real-world weather.

Other improvements include a beefier, more interactive air traffic control system, which allows pilots to request altitude changes, change destinations, or alter flight plans en route. Major airports now feature taxiway and runway signs, making navigation on the ground much easier. And *FS 2002*'s generic GPS has been replaced with one modeled on a real-world multi-functional Garmin GPS.

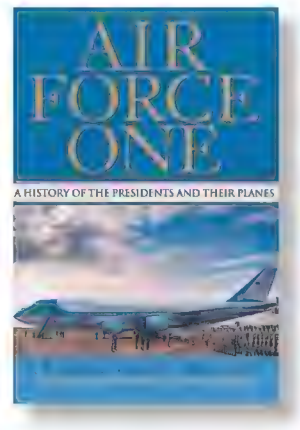
All in all, *FS 2004* may not persuade every simmer to upgrade, but it does just enough to make dedicated fans happy to shell out money they would have likely spent on third-party add-on programs to achieve the same results.
—Tom LeCompte is a freelance writer and private pilot living in western Massachusetts.

Air Force One

by Kenneth T. Walsh. Hyperion Books, 2003. 161 pp., $24.95.

Author Kenneth T. Walsh, *U.S. News & World Report*'s White House correspondent since 1986, has talked frequently with four U.S. presidents and allows us a glimpse of them aboard their famous aircraft. He also recounts historic decisions made by presidents while airborne, beginning with Franklin Roosevelt, the first president to fly while in office, and follows the path taken by Air Force One on September 11, 2001.

Too much of the book, unfortunately, consists of superficial generalizations about history (not aviation): "While Ike was a countrified Kansan, Kennedy was an urbane Bostonian"; Gerald Ford was "smart, decent, and hardworking" and "made some solid decisions as president"; Ronald Reagan "helped to vanquish the Soviet Union." Walsh's summaries of how past and present commanders-in-chief perceived the role of these aircraft are equally simplistic: Lyndon Johnson "saw the plane as a private preserve and locker room"; Bill Clinton "looked at Air Force One as a haven where he could operate on his own schedule and in his own manner"; George W. Bush "sees Air Force One as his private place, just as all presidents do."

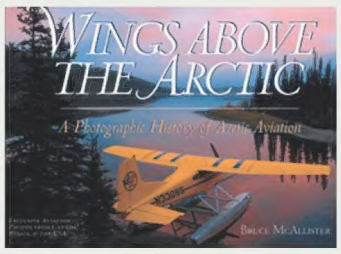


This volume will interest presidential historians more than aviation buffs. The aeronautical details are unsophisticated and contribute no new knowledge about the airplanes, which range from FDR's C-54 Skymaster to the current VC-25 presidential aircraft, a Boeing 747. The same is true of military details. Less-publicized aircraft used to transport presidents, and the role of the Air Force's 89th Airlift Wing at Andrews Air Force Base, Maryland—to assure continuity of government in wartime—are not discussed. With his extraordinary access, Walsh owed us more.
—Robert F. Dorr is the author of 60 aviation books, including his own take on Air Force One.

BRIEFLY NOTED

Wings Above the Arctic: A Photographic History of Arctic Aviation

by Bruce McAllister. Roundup Press, 2003. 229 pp., $34.95.



The cozy nature of this survey owes much to the author's provincial writing style and the large, grainy images he's chosen to show the peculiar fates of aircraft at the world's northernmost outposts. *Wings* contains a flurry of tales about U.S., Russian, and Canadian expeditions, but in a region where every bush pilot has a good survival yarn, the wiser choice may have been to delve deep rather than cast widely.

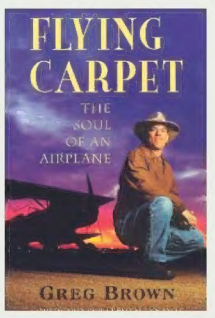
Face to Face with the Bomb: Nuclear Reality After the Cold War

by Paul Shambroom. Johns Hopkins University Press, 2003. 121 pp., $34.95.

Paul Shambroom documented the alien world of U.S. nuclear readiness in its "natural working state" before the terrorist attacks of 2001 terminated his access to them. His photographs of silos, subs, and the weapons themselves were pre-approved and staged by the military. The 83 resulting full-page images are self-conscious and coldly awkward, thus their chilling power.

Flying Carpet: The Soul of an Airplane

by Greg Brown. Iowa State Press, 2003. 319 pp., $29.99.



Many of these anecdotes, drawn from the author Greg Brown's logbook, have appeared in leading pilot magazines. His vignettes span his days as a neophyte pilot courting his girlfriend to his more recent adventures as a flight instructor, husband, and father. A map with each of his charming tales shows the flight covered in the story.

CALENDAR

October 1–3
Military History Symposium: "Winged Crusade, The Quest for American Air and Space Power." U.S. Air Force Academy, CO, (719) 333-8593/8543, *www.usafa.af.mil/dfh/smypo20.*

October 3–5
AirFest: 100 Incredible Years of Flight. Performances by U.S. Navy Blue Angels, Canadian Snowbirds, and Sean D. Tucker. Long Beach, CA, (650) 869-4160, *www.shorefest.com.*

October 4
SR-71 Forum. Meet former SR-71 aviators; join panel discussions. Virginia Aviation Museum, Richmond International Airport, VA, (804) 236-3622.

October 4–6
Reunion: AC-119 gunship air crews. Sheraton Four Points, Fort Walton Beach, FL, (707) 592-4492, *www.ac-119gunships.com.*

October 6–9
Reunion: VP-4, U.S. Navy Patrol Squadron. Las Vegas Flamingo Hotel, NV, (702) 255-1218.

October 18
All Helicopter Airshow. Helicopter rides and demonstration flights. American Helicopter Museum, Brandywine Airport, West Chester, PA, (610) 436-9600.

October 24
Cosmic Rendezvous: An Evening Among the Stars. Gala benefit for the Challenger Center for Space Science Education. Westin Galleria Ballroom, Houston, TX. To purchase tickets, call (703) 683-9740.

November 5
Realizing the Dream of Flight: A Symposium Honoring the Centennial of the Wright Brothers' First Flight. Reinberger Auditorium, Great Lakes Science Center, Cleveland, OH, (216) 421-9622, *mdb@historyenterprises.com.*

November 8
Swing Out to Victory! World War II-era swing dance. Dressing in Allied uniforms or vintage dress encouraged but not required. Canadian Warplane Heritage Museum, Mount Hope, Ontario, Canada, (905) 679-4183, ext. 221, *www.warplane.com.*

November 15
Celebrating Aviation—Yesterday, Today, and Tomorrow. Naples Florida Municipal Airport, FL, (239) 403-4838, *NaplesAviationDay.com.*

Organizations wishing to have events published in Calendar should fax press releases two months in advance to (202) 275-1886 or mail them to Calendar, Air & Space/Smithsonian, *MRC 951, P.O. Box 37012, Washington, DC 20013-7012.*

CREDITS

Memoirs of a Pan Am Brat. Doug Wilburn retired from politics to a golf course in North Carolina.

Dude, Where's My Airplane? Phil Barber, a writer in Calistoga, California, remains in complete control of his Plymouth Voyager.

Air(show) Assault. Shelby G. Spires is an aerospace reporter for the *Huntsville Times.* While researching this story, he flew in a Vietnam-era UH-1 "Huey."

The Dept. of Etc. Carolyn Russo is a staff photographer at the National Air and Space Museum. Her last book was *Women and Flight: Portraits of Contemporary Women Pilots.*

The Spin Debate. Joseph Bourque last wrote for *Air & Space/Smithsonian* about the U.S. Customs' coastal surveillance of drug runners (June/July 1999).

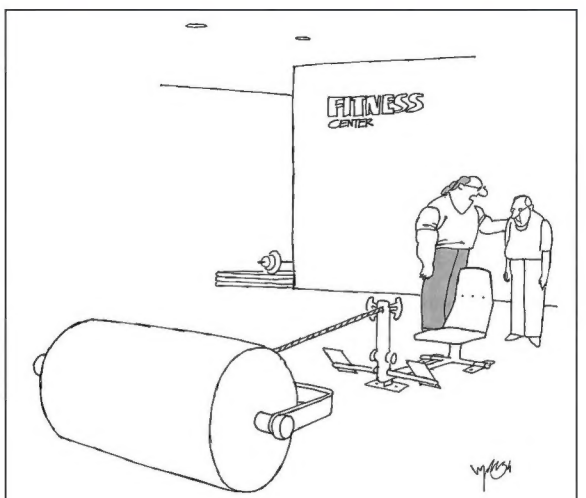
Backgrounder: State of the Station. Tony Reichhardt is a consulting editor at *Air & Space.*

The Contender. Bill Sweetman first visited Airbus' Toulouse headquarters in 1975, as a new reporter for *Flight International.*

Pod People. James Oberg spent 22 years at mission control in Houston; now he is an author and a lecturer on spaceflight.

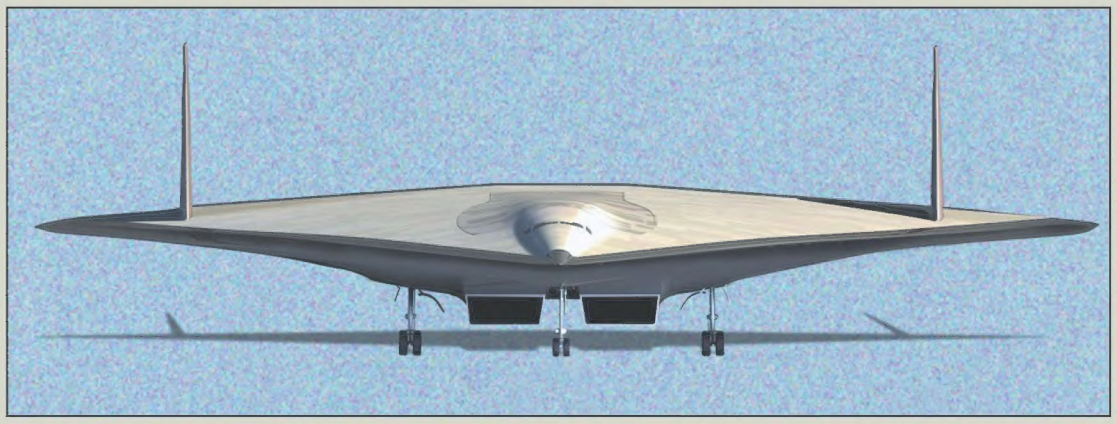
Restoration: Diamonds in the Wreck. Sam Goldberg is an associate editor at *Air & Space.*

Expert Witness. Lieutenant Colonel Robert L. Brown, U.S. Air Force (ret.), flew as an EWO on B-52Gs, RC-135s, and AC-130s. He is an adjunct faculty member at the University of South Carolina at Sumter.



"If you're a flier, this gets you in shape for pulling out of 9-G dives."

COMING IN DECEMBER



PAUL DIMARE (2)

IMAGINE A FUTURE

• where clean, inexhaustible hydrogen, extracted from the sea, fuels hypersonic airliners for intercontinental travel;

• where interstate highways no longer gobble up green space; instead, personal air vehicles, sleek and autonomous, convey their owners to programmed destinations;

• where traveling by airliner can be as zipless as boarding a bus;

• where giant, unpiloted spanloaders are in constant motion transporting goods around the world;

• where astronauts travel to the L2 libration point to service arrays of telescopes searching for Earth-like planets;

• where miners extract helium-3 from sites near Moon Base Alpha…

Flight has come so far in the first 100 years, imagine what will be accomplished in the next 100.

We already have.

In the next issue, we'll show you air transportation on Earth and beyond in the year 2103.

A personal air vehicle, with lift fan, landing skid, and VLW (very large windshield). Top: The Global Clipper, a Mach 10 airliner, will carry passengers to coastal airports.

Also in December…

The Opening
An unveiling of the aircraft on view at the National Air and Space Museum's Steven F. Udvar-Hazy Center, starting December 15.

Vulcan
The U.S. Air Force has its B-52; the Royal Air Force had the Vulcan. In what could be the most ambitious restoration project ever attempted, two U.K. groups are vying to get the huge delta-wing nuclear bomber flying again.

Landing Lottery
Destination: Mars. But where on the surface of the planet's 90 million square miles would you land your robotic probe?

ON THE WEB SITE

www.airspacemag.com

Have you been to the Web site lately? More than 140 articles from back issues are available for reading online. Two sections are of particular interest to subscribers. "Supplemental" contains downloadable files elaborating on *Air & Space* features. A collection of rare stereographic photographs of the moon's surface is one supplement; another is a Quicktime movie illustrating the effects of flutter. In "Sightings" you will find Quicktime video clips, including one of a C-130 Hercules landing aboard the USS *Forrestal* and another of the Convair XFY-1 Pogo taking off and landing.

MISSING AN ISSUE?
For back issues and reprint policies, visit the Web at *www.airandspacemagazine.com/asm/mag/index/backissues.html* or send a check for $7.00 ($9.50 international), payable to the Smithsonian Institution, to *Air & Space*, P.O. Box 37012, Victor Bldg., Suite 7100, MRC 951, Washington, DC 20013-7012

Not every issue of the magazine is available. For a list of editions that are out of print, check the Web at the above address.

LIBRARY OF CONGRESS

Lifeguards ("station men") and kids gathered at Kitty Hawk as the Wrights prepared to try getting the Flyer *aloft.*

So Close...

The last issue's excerpts from *The Papers of Wilbur and Orville Wrght, Volume One, 1899–1905* (McGraw-Hill, 2001) showed the brothers in high spirits, with Orville bragging to a fellow flight enthusiast about the superiority of the brothers' propellers. In this issue's excerpt, Orville, in the telegraphic style he used for diary entries, details a trial in which Wilbur and the *Flyer* came within a hair of achieving the first significant powered flight.

Orville Wright's diary D, Dec. 14, 1903
At half past one o'clock we put out signal for station men, and started for hill, which took us about 40 minutes. After testing engine, with help of men...we took machine 150 ft. uphill and laid track on 8° 50' slope. A couple small boys, who had come with the men from the station, made a hurried departure over the hill for home on hearing the engine start. We tossed up coin to decide who should make first trial, and Will won. After getting adjustments of engine ready I took right end of machine. Will got on. When all was ready Will attempted to release fastening to rail, but the pressure due to weight of machine and thrust of screws [propellers] was so great that he could not get it loose. We had to get a couple of the men to help push machine back till rope was slipped loose. While I was signaling man at other end to leave go, but before I myself was ready, Will started machine. I grabbed the upright the best I could and off we went. By the time we had reached the last quarter of the third rail (about 35 to 40 feet) the speed was so great I could stay with it no longer. I snapped watch as machine passed end of track. (It had raised from track six or eight feet from end.) The machine turned up in front and rose to a height of about 15 feet from ground at a point somewhere in neighborhood of 60 feet from end of track. After thus losing most of its headway it gradually sank to ground turned up at an angle of probably 20° incidence. The left wing was lower than the right so that in landing it struck first. The machine swung around and scraped the front skids (bows running out to front rudder) so deep in sand that one was broken, and twisted around until the main strut and brace were also broken, besides the rear spar to lower surface of front rudder. Will forgot to shut off engine for some time, so that the record of screw turns was mostly taken while the machine was on the ground. The engine made 602 rev. in 35 ½ s. Time of flight from end of track was 3 ½ sec. for a distance of 105 ft.

Moments & Milestones is produced in association with the National Aeronautic Association. Visit the NAA Web site at www.naa-usa.org *or call (703) 527-0226.*

LOGBOOK

Awards
John H. Glenn Jr. is this year's winner of the NAA's Wright Brothers Memorial Trophy, awarded annually to a civilian for public service of enduring value to U.S. aviation. The trophy will be presented at the Wright Brothers Memorial Dinner, hosted by the Aero Club of Washington, on December 12, 2003, at Ronald Reagan National Airport in Virginia.

The NAA awarded the 2003 Katharine Wright Award to Dr. Eilene Galloway for decades of contributions to the U.S. space program, including helping write the legislation that created NASA. Galloway gave her acceptance speech by video to the audience at the Ninety-Nines, Inc.'s ceremony.

Nominations
Nominations are being accepted until January 10, 2004, for the Frank G. Brewer Trophy, which is awarded annually to an individual, group of individuals, or organization for contributions of enduring value to U.S. aerospace education.

Nominations for the Robert J. Collier Award will be accepted from November 1, 2003, until January 31, 2004. The Collier Award is given annually for the greatest achievement, the value of which was demonstrated during the preceding year, in improving the performance, efficiency, and safety of air and space vehicles in the United States.

Events
The NAA's Annual Fall Awards Banquet will be held on November 10, 2003. Presentations include the National and World Record Flights, Katherine and Marjorie Stinson Award, Cliff Henderson Award, Elder Statesman of Aviation Award, and the Clarence Mackay Trophy. More information is available from the NAA (contact information at left).